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Guidelines for the Provision of Garbage Reception Facilities at Ports Under MARPOL Annex V

Barbara Wallace
James M. Coe

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A Technical Report of the *Fishery Bulletin*

Guidelines for the Provision of Garbage Reception Facilities at Ports Under MARPOL Annex V

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Abstract

This report offers guidelines for the provision of adequate port reception facilities for vessel-generated garbage under the requirements of Annex V of the International Convention for the Prevention of Pollution From Ships, 1973 (MARPOL 73/78), Regulations for the Prevention of Pollution by Garbage from Ships. MARPOL Annex V prohibits at-sea disposal of plastic materials from vessels, and specifies the distance from shore at which other materials may be dumped. Annex V also requires the provision of port reception facilities for garbage, but it does not specify these facilities or how they are to be provided. Since the at-sea dumping restrictions apply to all vessels, the reception facility requirement applies to all ports, terminals, and marinas that serve vessels. These guidelines were prepared to assist port owners and operators in meeting their obligation to provide adequate reception facilities for garbage. The report synthesizes available information and draws upon experience from the first years of implementation of MARPOL Annex V.

Manuscript accepted 14 November 1994.

Chapter 1
Introduction

Background

This document offers guidelines for ports required to provide reception facilities for vessel-generated garbage by Annex V of the International Convention for the Prevention of Pollution From Ships, 1973 (MARPOL 73/78), Regulations for the Prevention of Pollution by Garbage from Ships (Appendix 1). MARPOL Annex V is an international treaty designed to address on a global scale the problem of at-sea disposal of vessel-generated garbage.

In the United States, MARPOL Annex V is implemented by the Marine Plastic Pollution Research and Control Act of 1987 (P.L. 100–220), which amends the Act to Prevent Pollution from Ships. Regulations on reception facilities for garbage generated by the United States Coast Guard (USCG) are included in 33 CFR 158; those for vessels carrying garbage are included in 33 CFR 151. Section 158.133(c) of these regulations requires that "all ports and terminals under the jurisdiction of the United States, including commercial fishing facilities, mineral and oil shorebases, and recreational boating facilities, have a reception facility" that meets the following criteria for adequacy established in Section 158.410(a):

> (1) Is capable after August 28, 1989 of receiving APHIS [United States Department of Agriculture, Animal and Plant Health Inspection Service] regulated garbage at a port or terminal no later than 24 hours after notice . . . unless it only receives ships that—
>
> (i) operate exclusively within the navigable waters of the United States;
>
> (ii) operate exclusively between ports or terminals in the continental United States; or
>
> (iii) operate exclusively between continental United States ports or terminals and Canadian ports or terminals.
>
> (2) Is capable of receiving medical wastes or hazardous wastes defined in 40 CFR 261.3, unless the port or terminal operator can provide to the master, operator, or person in charge of a ship a list of persons authorized by federal, state, or local law or regulation to transport and treat such wastes;
>
> (3) Is arranged so that it does not interfere with port or terminal operations;
>
> (4) Is conveniently located so that mariners unfamiliar with the port or terminal can find it easily and so that its use will not be discouraged;
>
> (5) Is situated so that garbage from ships which has been placed in it cannot readily enter the water; and
>
> (6) Holds each federal, state, and local permit or license required by environmental and public health laws and regulations concerning garbage handling.

To certify that a port or terminal meets the requirements for garbage reception facilities, the USCG issues a Certificate of Adequacy (COA), which is required if a port or terminal receives oceangoing tankers or vessels of 400 gross tons or more, or fishing vessels that offload more than 500,000 pounds of commercial fishing product during a calendar year.

On a COA application, the port or terminal self-certifies that garbage received from foreign ports can be handled within 24 hours of notification of the need for the service, and that all garbage that the master of the vessel wishes to discharge can be received (except for large quantities of spoiled or damaged cargo or garbage from ships not having commercial transactions with the port or terminal).

If a port or terminal that comes under the COA requirement lacks adequate reception facilities, the USCG may bar vessels from entering that port or terminal.

Ports and terminals not required to file a COA with the USCG must still meet requirements for garbage reception facilities. Vessels may be denied entry to ports and terminals with inadequate reception facilities, whether or not they are required to have a COA. This includes recreational boating facilities.

These guidelines were prepared to assist United States port owners and operators in meeting their obligation to provide adequate port reception facilities, and to ensure that such facilities are available to vessels. The report synthesizes available information and draws upon experience from the first years of implementation of MARPOL Annex V. The text of MARPOL Annex V is included as Appendix 1. Appendix 2 presents the form

that accompanies MARPOL Annex V for reporting alleged inadequacy of port reception facilities for garbage.

Cooperation Between Vessel, Port, and Disposal Facility

There are three components involved in the implementation of Annex V: the vessel, the port reception facility, and the ultimate disposal facility. However, only the vessel and the port reception facility are explicitly mentioned in the treaty. Annex V prohibits at-sea disposal of plastic materials from vessels and specifies the distance from shore at which other materials may be dumped. Figure 1 summarizes the garbage discharge restrictions for vessels. Annex V also requires the provision of port reception facilities for garbage. It does not, however, specify what these facilities should be or how they are to be provided, but merely states that service must be provided ". . . without causing undue delay to ships, and according to the needs of the ships using them." Since the at-sea dumping restrictions apply to all vessels, the reception facility requirement applies to the entire range of ports, terminals, and marinas which serve vessels.

The vessel, port reception facility, and ultimate disposal facility each have personnel who must work together to achieve compliance: the owner, the person in charge on site, and the waste handler (Fig. 2). In some cases, these roles may be combined in the same person. Successful implementation of MARPOL Annex V requires linkages between the three components: between the vessel and the port reception facility, and between the port reception and ultimate disposal facilities (Fig. 3). When these links do not function, implementation of Annex V will be incomplete.

Arrangements for shoreside collection and disposal of vessel-generated waste are generally made by either vessels or by ports (Fig. 3). Where arrangements are made by the port, collection and disposal services are typically provided by the port itself, the local government or municipality, or a commercial waste management company hired for that purpose. Arrangements made by a vessel are typically set up by the ship's agent with commercial waste management companies, with or without assistance from the port.

Administration

No matter which approach a port chooses, it is responsible to ensure the availability of port reception facilities that meet the needs of vessels without causing undue delay. Administrative arrangements will be necessary to plan, implement, and operate a solid-waste management system for vessel-generated garbage. The first step is for the port operators to decide on the appropriate organizational structure and to assign responsibility. The same person may be responsible for planning, implementing, and operating the waste management system, or the responsibility for those tasks may belong to different persons.

In general, port operators may either hire or assign an individual or group to oversee the port's garbage management facilities, or they may hire an outside contractor. If an outside contractor is used, someone at the port should be assigned to oversee and review the work. This document contains information useful to port operators and managers no matter which approach they use to provide reception facilities for garbage.

Issues and Options

Since MARPOL Annex V applies to all vessels, it encompasses a broad range of wastes. Figure 4 illustrates options for the shoreside collection, treatment, storage, and transport of the many types of vessel-generated garbage. As illustrated in Figure 4, foreign-generated wastes quarantined by APHIS require specific collection, treatment, storage, and transportation methods (see Chapter 2). Some ports may provide all the options shown; others may need to provide only one or two if those options meet the needs of the vessels using the port and are sufficient for the amounts of garbage coming from those vessels.

Figure 4 also indicates some of the issues that must be addressed: waste-stream characterization, handling requirements for special garbage, equipment, space and site requirements, recycling, cost, and efforts to encourage compliance. The remainder of this document focuses on these issues.

Definition of Terms

The following terms are employed in these guidelines:

Vessel

The word "vessel" (not ship as is used in MARPOL Annex V) is used to emphasize that all ships, boats, submarines, fixed and floating platforms, and other watercraft are included in the requirements of Annex V.

Garbage

To be consistent with the language of MARPOL Annex V (Appendix 1), these guidelines use the word "gar-

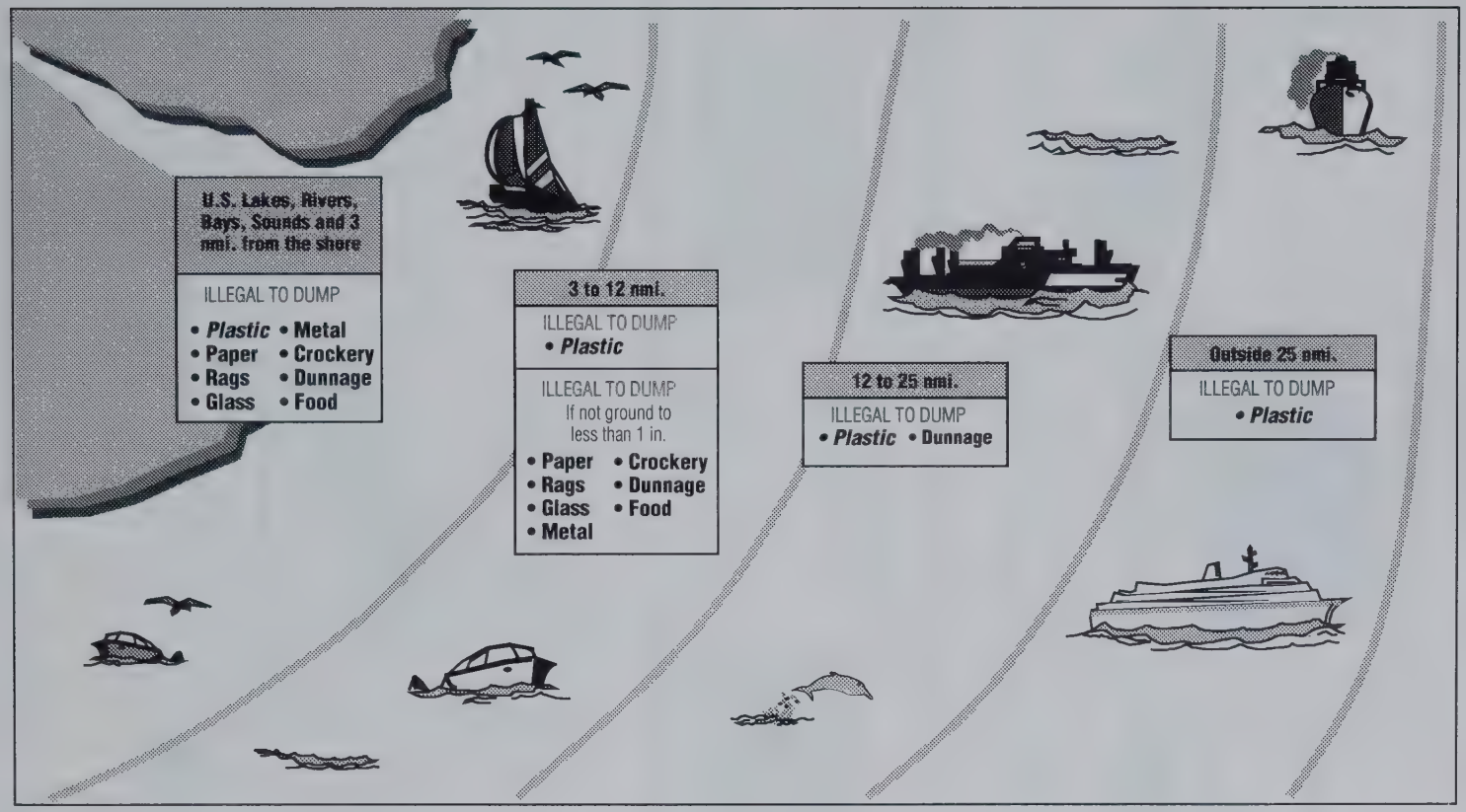
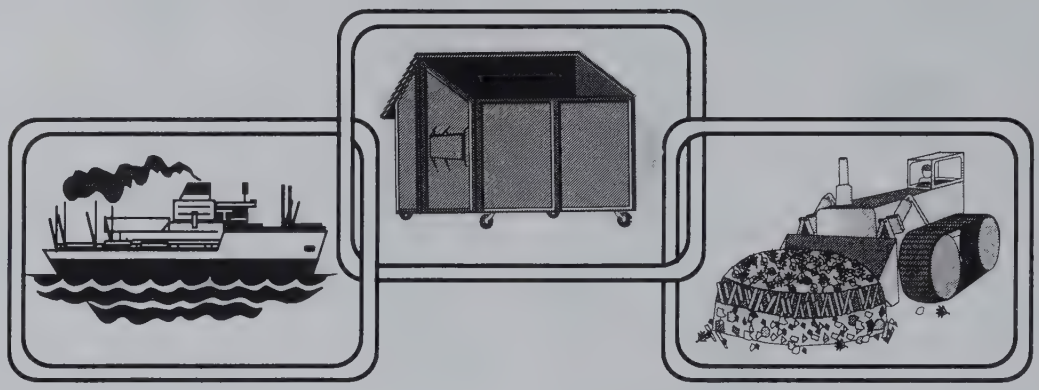

U.S. Lakes, Rivers, Bays, Sounds and 3 nmi. from the shore
ILLEGAL TO DUMP
• Plastic • Metal
• Paper • Crockery
• Rags • Dunnage
• Glass • Food
3 to 12 nmi.
ILLEGAL TO DUMP
• Plastic
ILLEGAL TO DUMP
If not ground to less than 1 in.
• Paper • Crockery
• Rags • Dunnage
• Glass • Food
• Metal
12 to 25 nmi.
ILLEGAL TO DUMP
• Plastic • Dunnage
Outside 25 nmi.
ILLEGAL TO DUMP
• Plastic

Figure 1

Summary of garbage dumping restrictions under MARPOL Annex V. More restrictive rules apply within special areas. The Wider Caribbean region, which includes the Gulf of Mexico, has been designated a special area, but discharge restrictions cannot be enforced there until adequate port reception facilities for garbage have been established in the region.



- Owner
- Captain
- Waste Handler
- Ship's Agent

- Port Authority/Owner
- On-Site Management
- Waste Handler/Hauler

- Public Administration/Owner
- On-Site Management
- Waste Handler

Figure 2

The various personnel who must work together to achieve compliance with Annex V regulations. Within each of the three components—the vessel, port, and ultimate disposal facility—personnel must cooperate to make their component a functioning link in Annex V implementation.

bage." However, for the American reader the words "trash" or "refuse" would be equally appropriate. Annex V Regulation 1 (1) defines "garbage" as "all kinds of victual, domestic and operational waste excluding fresh fish or parts thereof, generated during the normal operation of the vessel and liable to be disposed of continuously or periodically except those substances which are defined or listed in the Annexes to the present Convention."

Regulations 3, 4, and 5 (subject to the exceptions in Regulation 6) prohibit the at-sea disposal of plastics anywhere and restrict the at-sea disposal of other types of vessel-generated garbage including dunnage, lining, and packing materials that will float; food waste; paper; rags; glass; metal; bottles; crockery; and similar material. Fish wastes generated during fishing or fish processing at sea are not classified as garbage under Annex V.

Plastics

According to Annex V Regulations 3 and 5, the term "plastics" includes, but is not limited to, synthetic ropes, synthetic fishing nets, and plastic bags. For the purpose of further guidance on the meaning of the term, "plastics" is defined by United States Coast Guard regulation 33 CFR 151.05 as

> "any garbage that is solid material, that contains as an essential ingredient one or more synthetic organic high polymers, and that is formed or shaped either during manufacture of the polymer or polymers or during the fabrication into a finished product by heat or pressure or both.
>
> Note: Plastics possess material properties ranging from hard and brittle to soft and elastic. Plastics are used for a variety of marine applications including, but not limited to: food wrappings, products for personal hygiene, packaging (vaporproof barriers, bottles, containers, and liners), ship construction (fiberglass and laminated structures, siding, piping insulation, flooring, carpets, fabrics, adhesives, and electrical and electronic components), disposable eating utensils and cups (including styrene products), bags, sheeting, floats, synthetic fishing nets, monofilament fishing line, strapping bands, hardhats, and synthetic ropes and line."

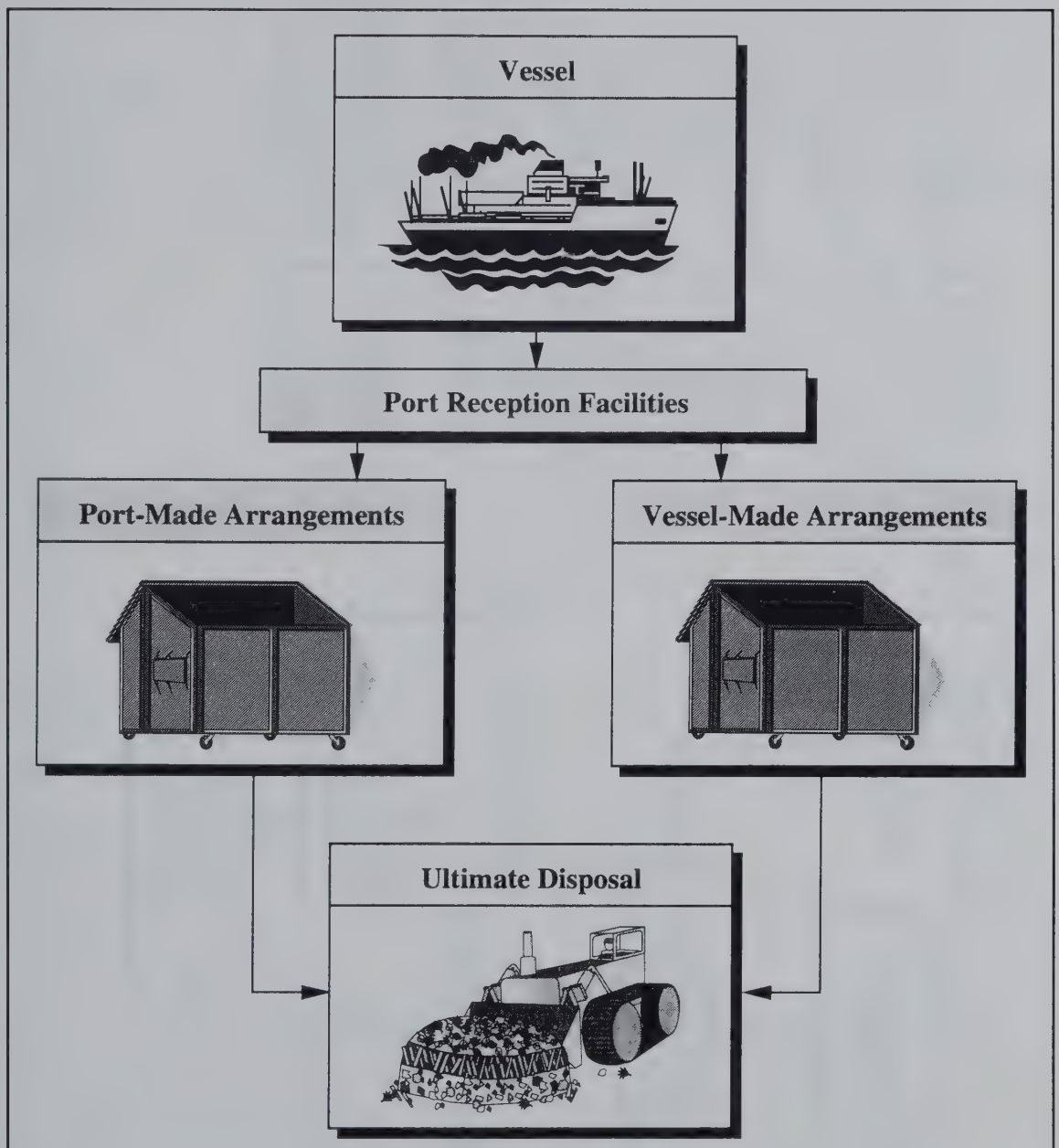


Figure 3
The three components necessary to providing port reception facilities for garbage: the vessel, port, and ultimate disposal facility. Either the port or the vessels may be responsible for arranging for collection of wastes at the port.

Port

The word "port" is used in this document to denote a terminal, commercial fishing facility, marina, or any other type of dock, pier, berth, or boatyard that is required to provide port reception facilities for garbage.

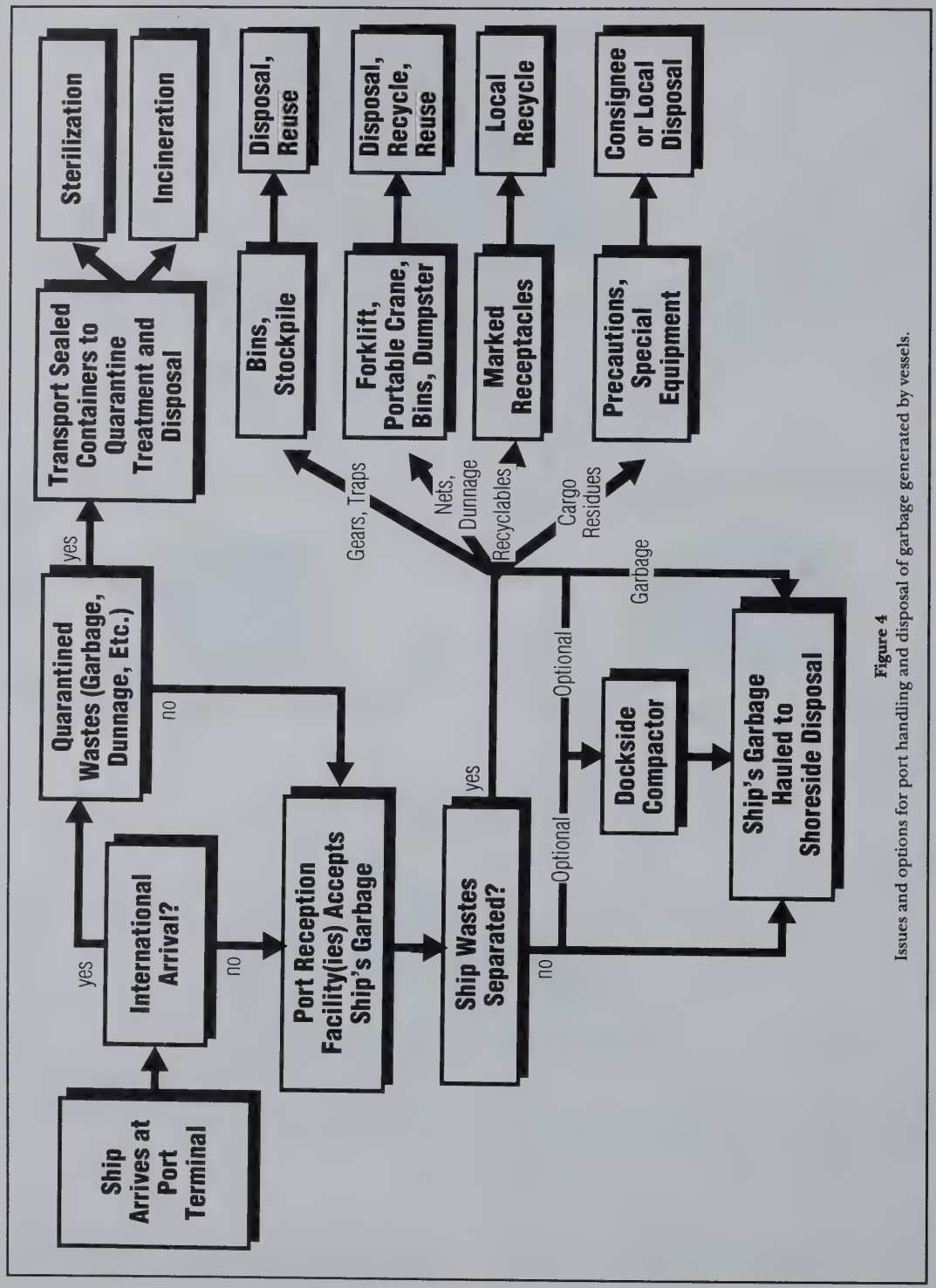


Figure 4
Issues and options for port handling and disposal of garbage generated by vessels.

Special Area

The term "special area" refers to the provisions of Regulation 5 of MARPOL Annex V. A special area is an area where, because of oceanographic or ecological conditions or the characteristics of vessel traffic, stricter at-sea disposal regulations are in place. In the United States, the Gulf of Mexico is designated a special area as part of the Wider Caribbean Special Area. However, until adequate port reception facilities are in place in the region and proper notification has been made to the International Maritime Organization, the body which oversees the MARPOL Convention, the more restrictive disposal requirements are not in effect. The Wider Caribbean Special Area was so designated after the passage of MARPOL Annex V and therefore is not listed in Regulation 5 of MARPOL Annex V (see Appendix 1).

Chapter 2
Solid-waste Management

Solid-waste management is an integrated series of activities involving collection, treatment, storage, transportation, and disposal. Port operators should first assess their existing solid-waste management system. Unless the port is being newly constructed, there is some sort of waste management system in place, but it may or may not be systematically designed and documented. Only after existing conditions are evaluated should changes be made. This chapter outlines one approach to assessing a solid-waste management system and determining a strategy for improving it if necessary (Fig. 5).

Assessment of an Existing System

Administration

Someone must be placed in charge of assessing existing waste management practices. This person may be assigned or hired specifically to conduct the assessment, or may be the person in charge of assuring the availability of adequate port reception facilities. Typically, the port operator either assigns a staff person or hires an outside contractor.

It is useful for port management and port users to exchange information on needs and options in planning and promoting the garbage facility. Formation of an advisory panel composed of leaders from the port, port user groups, and waste handlers has proven useful in some cases. Visible support from port management is critical to assessing and improving waste management operations.

A written plan outlining the existing waste management system and related policies may be appropriate for some ports. Such a plan should specify the locations and types of storage and removal equipment throughout the port or harbor; the system for monitoring what types and quantities of garbage are received and handled by the port; arrangements for special types of garbage such as large bulky items, recyclable materials, and garbage which includes or has been in contact with foreign food items; and provisions to cover equipment and handling costs.

In order to identify and define waste system needs, port characteristics, vessel requirements, and port requirements must be considered (Fig. 5). An understanding of these factors helps ensure coordination between the port and the vessels using it.

Waste-stream Characterization

Waste-stream characterization is conducted to develop an understanding of waste composition and quantity. Determination of the capacity needed by a reception facility should be based on the need of each type of vessel and on the number of different types of vessels using the port. This calculation should take into account the types and quantities of garbage discharged by vessels at sea in accordance with the provisions of Regulations 3, 4, and 5 of Annex V.

Waste composition and quantity, as well as timing of delivery, are key considerations in planning for collection, transportation, and disposal of solid waste. These characteristics of the waste stream determine both the capacity and the types of collection systems needed, particularly if there are wastes requiring special handling such as foreign garbage, medical waste, cargo residue, and large, bulky items such as fishing gear, pallets, etc.

Types of Waste—Table 1 lists some types of waste received by ports, organized under two major headings: domestic waste and operational waste. These examples illustrate the fact that waste may be received from all sorts of vessels and all types of activities.

Domestic waste includes all types of food waste and waste generated in living spaces on board a vessel. Food waste comprises any spoiled or unspoiled victual substances such as fruits, vegetables, dairy products, poultry, meat products, food scraps, and food particles, and any other material contaminated by such wastes that is generated on a vessel, principally in the galley and dining areas.

Operational waste includes cargo-associated waste, maintenance waste, and cargo residue defined as garbage. Cargo-associated waste is material which has become waste as a result of use on board a vessel for cargo stowage, handling, and protection. It includes, but is not limited to, dunnage, shoring, pallets, lining and packing material, wrappings, plywood, paper, cardboard, wire, and steel strapping. Maintenance waste is material

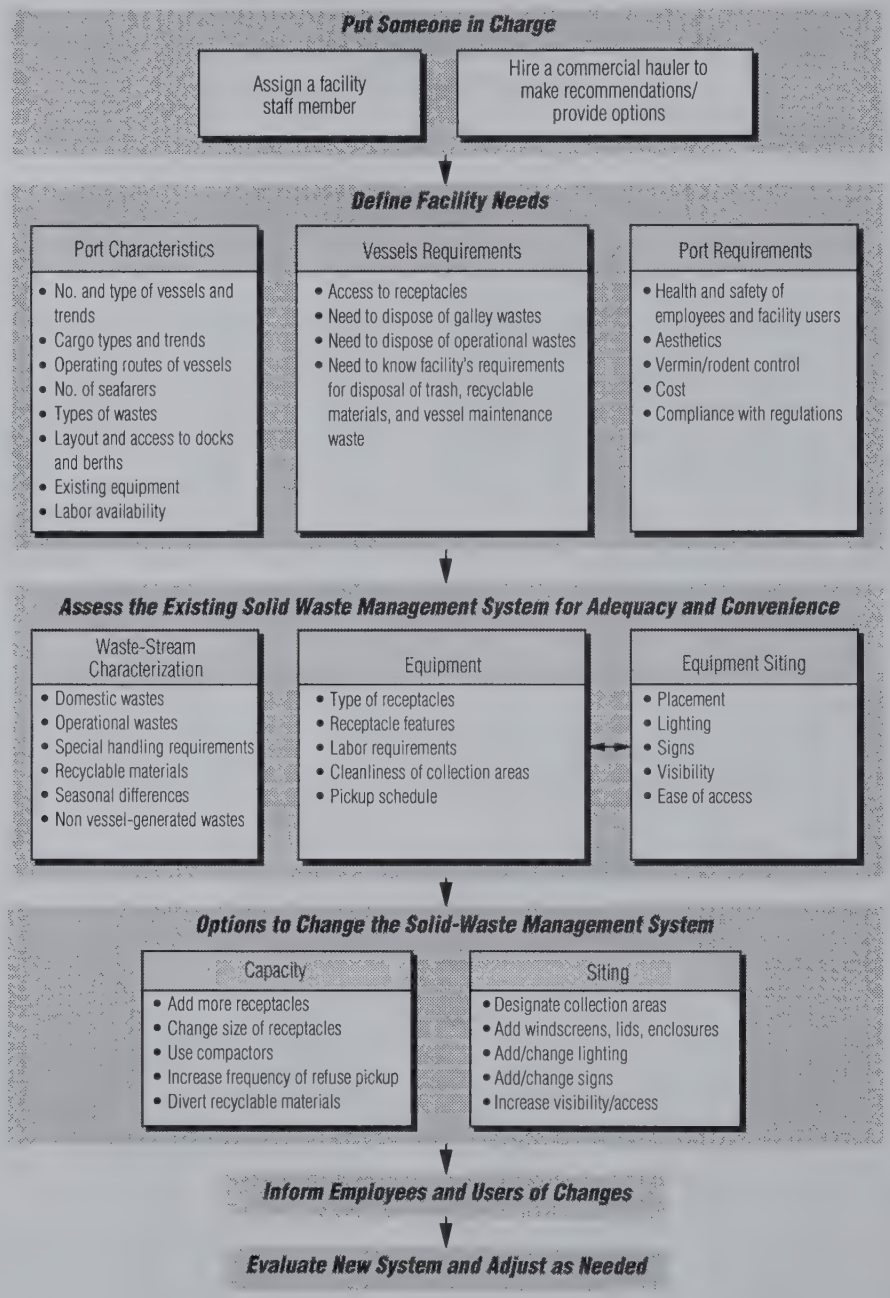

Put Someone in Charge
Assign a facility staff member
Hire a commercial hauler to make recommendations/ provide options
Define Facility Needs
Port Characteristics
• No. and type of vessels and trends
• Cargo types and trends
• Operating routes of vessels
• No. of seafarers
• Types of wastes
• Layout and access to docks and berths
• Existing equipment
• Labor availability
Vessels Requirements
• Access to receptacles
• Need to dispose of galley wastes
• Need to dispose of operational wastes
• Need to know facility's requirements for disposal of trash, recyclable materials, and vessel maintenance waste
Port Requirements
• Health and safety of employees and facility users
• Aesthetics
• Vermin/rodent control
• Cost
• Compliance with regulations
Assess the Existing Solid Waste Management System for Adequacy and Convenience
Waste-Stream Characterization
• Domestic wastes
• Operational wastes
• Special handling requirements
• Recyclable materials
• Seasonal differences
• Non vessel-generated wastes
Equipment
• Type of receptacles
• Receptacle features
• Labor requirements
• Cleanliness of collection areas
• Pickup schedule
Equipment Siting
• Placement
• Lighting
• Signs
• Visibility
• Ease of access
Options to Change the Solid-Waste Management System
Capacity
• Add more receptacles
• Change size of receptacles
• Use compactors
• Increase frequency of refuse pickup
• Divert recyclable materials
Siting
• Designate collection areas
• Add windscreens, lids, enclosures
• Add/change lighting
• Add/change signs
• Increase visibility/access
Inform Employees and Users of Changes
Evaluate New System and Adjust as Needed

Figure 5

Steps in assessment of an existing solid-waste management system and design of an improved system (adapted from the U.S. Environmental Protection Agency).

collected by the engine and deck departments while maintaining and operating the vessel, such as soot, machinery deposits, scraped paint, deck sweepings, wiping waste, and rags. Cargo residues are treated as "garbage" under Annex V except when they are covered under other Annexes to the Convention.

Within these two categories of waste, there may be waste which cannot be treated as ordinary garbage and has special handing requirements. Many ports will, therefore, require some level of waste-stream separation to maintain quarantine and hygiene, and to control the transfer of wastes to their ultimate disposal through incineration or in landfills. Separate collection systems will be required for special refuse such as foreign food waste, medical waste, cargo residues, recyclables, and fishing gear or other large bulky items. The need for separation stems partly from solid-waste regulations and partly from practical considerations of waste handling.

Special handling procedures and techniques may be desirable or necessary in ports serving specialized fleets. Examples of this situation are fishing ports where fishermen need to discard nets and traps; bulk solid-cargo terminals where loading and unloading activities generate cargo residues; and livestock carriers where animals produce fecal and urine waste during the voyage. The port operators should inform seafarers and vessel operators whether vessel-generated garbage must be separated, whether there are advance notice or other landing requirements for a vessel to land specific types of waste at the port, and whether certain types of wastes cannot be landed and why.

Foreign Food Waste and Other Quarantined Garbage—In order to prevent the entry into the United States of a variety of very damaging livestock and plant pests and diseases, the Animal and Plant Health Inspection Service (APHIS) of the U.S. Department of Agriculture regulates food waste of foreign origin. This includes any garbage which may have come in contact with such food (wrapping, packaging, utensils, etc.). The implementation of MARPOL Annex V is likely to cause an increase in the amount of foreign food-contaminated waste being delivered to U.S. ports because plastics, including all food-contaminated plastics, can no longer be discharged at sea.

In the United States, if a port receives vessels from foreign ports it must have or provide access to reception facilities that meet APHIS regulations (33 CFR 158.410). Vessels are required (33 CFR 151.65) to provide ports with 24-h advance notification that they will need such services.

APHIS regulations (9 CFR 94) require the use of leakproof, covered containers for regulated garbage retained on a vessel while in United States ports. Regulated garbage that is offloaded must be in leakproof containers and offloading must be conducted under the supervision of an APHIS officer. The regulated garbage must be incinerated to ash or heated to an internal temperature of 212°F for at least 30 minutes and disposed of in a sanitary landfill.

In arranging for reception facilities for foreign food waste and other quarantined garbage, port operators should consider the following:

- increasing amounts of such garbage may be expected due to Annex V requirements;
- ports can meet their Annex V obligation for APHIS-regulated garbage by providing vessels with the means to contact third-party APHIS-approved haulers capable of proper disposal of such waste;

Table 1

Examples of types of waste received by port reception facilities for garbage. Adapted from A. T. Kearney (1991a).

Domestic Waste
Food wastes
Plastic wastes
Other materials
Paper
Metal
Glass, crockery
Operational Wastes
Maintenance wastes
Oily rags
Oily sorbent pads
Machinery maintenance supplies and residues
Soot and machinery deposits
Metal shavings
Broken parts and packaging for spares
Emptied packaging: metal, paper, glass, etc.
Emptied packaging: plastic
Ash and clinkers from coal boilers
Cargo-associated wastes
Dunnage, shoring
Pallets, lining and packing materials: wood and metal
Pallets, lining and packing materials: plastic
Strapping: wire and steel
Strapping: plastic
Hull maintenance supplies and residues
Rust
Broken parts and packaging for spares
Emptied packaging: metal, paper, glass, etc.
Emptied packaging: plastic
Garbage handling supplies and residues
Ash and clinkers from waste incinerators
Emptied packaging: metal, paper, glass, etc.
Emptied packaging: plastic
Cargo residues
Livestock wastes
Fishing gear
Bait refuse
Signal flares
Light bulbs

- there may be special requirements (such as custody, security, and liability) for increased delivery and temporary storage of this garbage;
- transportation must be available from port to APHIS-approved treatment and disposal facilities;
- arrangements must be made for vessels to deliver advance notice of need for garbage inspection; and
- arrangements must be made to track and respond to increased quantities of quarantined wastes due to Annex V implementation.

Medical Waste—In the United States, vessels are required (33 CFR 151.65) to provide ports with 24-h advance notification that they have medical waste to discharge. Ports can meet their Annex V obligation for medical waste by providing vessels with the name and means of contacting third-party haulers capable of receiving and handling such wastes (33 CFR 158.410).

Cargo Residue—Certain cargo residues, other than those regulated under MARPOL Annexes I and II (oil and noxious liquid substances carried in bulk, respectively), may not be suitably disposed of at reception facilities equipped to handle general garbage, because of safety hazards. Such substances may be regulated under other Federal legislation and may require special handling and disposal. The disposal of such cargo residue should be based on the physical, chemical, and biological properties of the substance and may require special handling not normally provided by garbage reception facilities. Substances requiring special handling are not always obvious, for example, there may be pesticide in bulk cargo residue.

Vessel operators should alert port operators when cargo residues will require special handling, but they may not always do so. Therefore, port operators should ask a vessel's crew what substances are included in any cargo residue to be handled, in order to identify special handling and disposal requirements and to protect the safety of the personnel involved with handling the waste. When in doubt, the most restricted handling practices should be used. In the United States, vessels are required (33 CFR 151.65) to provide ports with 24-h advance notification that they have hazardous waste to discharge. Ports can meet their Annex V obligation for hazardous waste by providing vessels with the name and means of contacting third-party haulers capable of receiving and handling such waste (33 CFR 158.410).

Recyclable Materials—Domestic and operational wastes may contain materials that are commonly recycled, including glass containers, aluminum cans, cardboard, newspaper, plastic containers, nets, wood, cable, and metal scrap. Ports and their surrounding jurisdictions can divert those materials away from landfills and incinerators by establishing collection systems for recyclables as part of the port reception facility. Ports with collection systems for recyclables should make seafarers aware of these systems and provide information on preparation of recyclable materials. Chapter 3 discusses port-based collection for recycling and presents guidelines for planning and implementing such a collection system.

Fishing Gear—Fishing gear brought into port for disposal may be bulky and difficult to transfer to the reception facility without the use of special equipment, and may have a strong, unpleasant odor. Separate reception facilities and equipment may be needed. Experience has shown that when a separate reception facility for fishing nets is established, with signs posted indicating that discarded nets are available to those who want them, reuse of the nets can be substantial, reducing waste disposal costs.

Quantity of Waste—The quantity of garbage delivered by any individual vessel will depend on what garbage treatment equipment (i.e., compactors, incinerators, and comminuters) is employed while underway, as well as on such factors as the vessel's function and route, and the number of passengers and crew. The amount of garbage handled by a port can be evaluated by recording size and emptying rate for all the receptacles in the port over a selected time period, and adding records of APHIS and recycled materials disposal. Port and terminal operators should consider the following when determining the quantity of garbage received per unit time:

- how full receptacles are at the time they are emptied;
- variation in rate of receptacle use over time (seasonal, weekend, etc.);
- variation in type of garbage delivered to different sections of the port or terminal;
- amount of APHIS and other specially handled wastes;
- amount of material recycled or re-used;
- changes in protection status of waters surrounding the port;
- local or regional boater education, awareness, and enforcement activities;
- level of utilization of port reception facilities for disposal of local (non-vessel) waste.

Ports serving special areas may receive larger quantities of all categories of garbage because of the stricter at-sea disposal requirements and because vessels should offload garbage prior to departure. The special area requirement to land all cargo-associated waste, for example, could create extra demand for quarantine inspection of dunnage and packing materials and for short-term storage because cargo-associated materials are more bulky than domestic or maintenance wastes.

Methods—Researchers and planners for port waste management have used a variety of methods to sample the stream of waste entering their jurisdiction and to forecast future waste management needs. Three methods used primarily to characterize municipal solid-waste streams, but which may be applied to ports, are briefly described here. They use either an output approach based on weight or volume, or an input approach. No single method will be applicable to all ports. Differences in such factors as climate, culture, and geography make it necessary for planners to adjust the methods to their own situation. It should be noted that a waste-stream characterization study can be expensive, and a formal study may not be appropriate in all circumstances.

The Weight-based Output Method—The weight-based output method involves sampling, sorting, and weighing each component of a representative sample of the solid-waste stream, to determine the proportion of each in the total waste stream. It is the most direct and frequently-used method for estimating recoverable resources in the waste stream. Weight is the measurement employed because that is the measure used by the waste industry. In its simplest form, the weight-based output method is relatively accurate and straightforward under average conditions. However, conditions are not always average. Chapter 3 includes instructions for applying the weight-based method for waste-stream characterization.

The Volume-based Output Method—The volume-based output method may be particularly useful for determining the need for capacity at a port reception facility. A pound of paper weighs the same whether it is neatly baled or crumpled; but the two storage methods involve differences in volume. In its simplest form, the volume-based output method employs waste disposal records to estimate the volume of garbage generated by a type of vessel. For example, the figures for total volume of waste disposed and the number and type of vessels registered in port during the same time period can be used to estimate the waste generated per vessel per day. This approach may be sufficient for ports where further detail on the components of the waste stream is not needed. However, for ports needing detailed information on garbage generation by type or category, additional effort will be required. In this case, the volume-based output method would involve sampling and sorting a representative sample of garbage by material composition or category, in order to calculate the proportion of different materials by volume in the total waste stream.

The Input Method—The second general method of characterizing waste streams is the input or materials-flow method. In studies of municipal solid waste, this method is used to analyze the flow of materials from production, through consumption, to disposal. Solid waste is estimated before discard, by studying potential wastes at their origins. This method has been modified to estimate the amount of waste generated on a vessel according to the materials brought onto the vessel. Such estimates have been used to indicate how much waste was not coming into ports for disposal, and thus what was most likely dumped at sea before Annex V entered into force. Vessel supply lists, assuming they are complete, may be useful in identifying what materials have been brought on board. The number of days at sea must also be considered. The input method is more useful for researchers interested in the rate of waste generation by vessels than for port solid-waste management planners interested in understanding the types and amounts of wastes to be handled at port reception facilities.

Waste-collection Arrangements

Annex V does not specify particular types of equipment for handling garbage. Many types of receptacles and vehicles may be used to collect, treat, store, and transport Annex V wastes. To a large degree, the receptacles and vehicles used are dependent on the types of wastes offloaded and the overall approach to waste-handling used at a particular port.

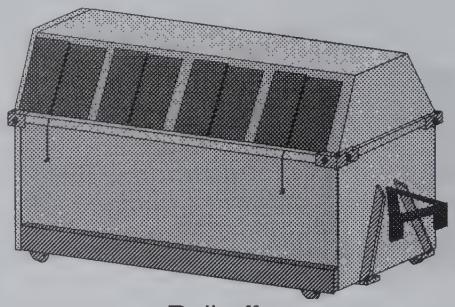
Receptacles—All ports, regardless of size, must have some type of receptacle for receiving garbage from vessels. A variety of containers and dumpsters may be suitable. Examples of the types of receptacles used in ports for collecting garbage are shown in Figure 6. Many refuse disposal companies rent or lease various sizes of containers compatible with their hauling equipment. Purchase of these compatible containers may also be an option.

Receptacles must be functional, but need not be elaborate. There are several factors to consider when evaluating and selecting receptacles:

Type—The types of receptacles used will depend on the number of different types of Annex V wastes to be collected separately. For example, receptacles used for collecting recyclables should be very different from those used for non-recyclable garbage, in order to avoid confusion among users and resulting contamination of the recycling bins. As previously stated, quarantined food waste requires separate receptacles which meet the specifications of APHIS regulations (9 CFR 94). For durability, receptacles constructed of galvanized metal or other rust-resistant materials are recommended. For items such as fishing nets, driftwood, and fish boxes, stockpile areas with pallets or designated areas with signs are effective.

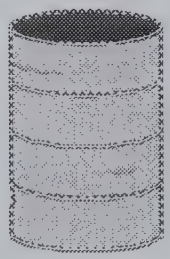
Capacity—Receptacle capacity should match demand. Receptacles that are too small require frequent emptying

to prevent collected wastes from overflowing, which can be costly in terms of labor. Overflowing waste receptacles are unsightly and can attract flies and vermin. Receptacles that are too large can also be costly because the port may

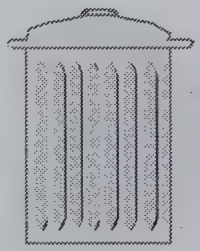


Roll-off

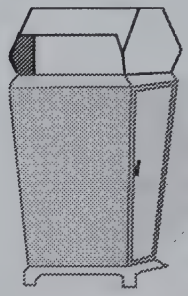
Mobile/plastic "Supercan"



Metal Barrel

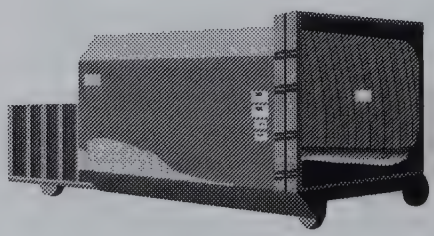


Metal with lid



Outer container with raised cover

Mobile/stationary dumpster with lid



Compacting dumpster

Figure 6
Examples of receptacles used in ports for collecting garbage.

be paying for capacity which is not needed. Seasonal fluctuations in demand for waste disposal also should be considered when determining receptacle capacity.

Weight—A receptacle's unladen weight and configuration will determine labor, equipment, and vehicle needs for moving empty receptacles within the port. It may be necessary to restrict the maximum load of receptacles because of operating limitations of handling equipment such as forklifts, cranes, and mechanized tipping equipment, or because of pier and dock load limitations. Receptacles that are lifted onto vessels must be compatible with the maximum load of available cranes, and may require wiresling attachments.

Space Requirements—The need for space should be considered at the time that equipment options are assessed since they are interrelated. Minimum requirements for most receptacles are determined by their length, width, and lid or door clearance. For receptacles with hinged lids, width when the lid is open should be considered, particularly if space is restricted. The space required depends in part on the number and types of receptables to be located together and the types of wastes to be collected at a single site

For mobile receptacles, consideration must be given to both storage and passage room (e.g., gate and door widths) as well as to space required during use. Space for collection vehicles must also be considered. Selection of receptacle type thus goes hand in hand with the selection of receptacle locations and the approach to waste handling.

Lids—For public health and safety, and for aesthetic reasons, receptacles should close securely. Tight-fitting lids, when used properly, control odors and prevent scavenging animals from getting into waste receptacles. Lids also help to minimize the opportunity for discarded wastes to be blown onto the ground or into the water by the wind. Litter around garbage collection points is unattractive, deters users, and creates additional work for port personnel.

Emptying Requirements—The ease of emptying waste receptacles is affected by their stability and maneuverability when fully loaded. Compatibility with the collection vehicle also affects the ease of emptying. For small receptacles which are emptied by hand, heavy-duty disposable liners ease emptying.

Ideally, receptacles and emptying schedules should be assessed at the same time to make sure they are complementary. In ports with an existing waste management system, the emptying schedule may need to be reassessed; in any case, it should be reviewed periodically. Emptying schedules also affect the need for labor and collection vehicles. More frequent collection reduces health, safety, and nuisance concerns, and necessitates less storage space, but may increase cost by using more vehicles and labor. Adjustments to emptying schedules have been found to improve service and aesthetics in some ports.

Security—Experience has shown that receptacles for garbage and recyclables can be targets of vandalism, misuse, and theft. Receptacle design and durability as well as siting should be considered when attempting to minimize these abuses.

Siting

Requirements—Some siting requirements for port reception facilities are specified in the regulations, and others follow logically from the requirements. Reception facilities should be sited to ensure that they do not interfere with port operations (33 CFR 158.410(a)(3)); that the garbage collected cannot readily enter the water (33 CFR 158.410(a)(5)); and that they are convenient to seafarers (33 CFR 158.410(a)(4)).

Convenience—Reception facilities for garbage must be convenient for the seafarers who use them, for personnel who transport garbage within the port, and for haulers who transport garbage from the port to an incinerator or landfill. If waste receptacles are located inconsistently or inappropriately, use and collection will be hampered. Depending upon the waste-handling approach used, garbage receptacles may be in place at all times or may be moved into place as needed to collect waste and stored elsewhere when not in use.

Distance to waste receptacles in ports is often cited by seafarers as encouraging or discouraging receptacle use. Short distances and easy access encourage use; long distances or other obstacles to access deter. Access to equipment such as carts, hoists, and forklifts may also affect convenience. A central collection site is sometimes established for large bulky items such as cardboard, cable, wood, metal, and fishing net.

In general, high-traffic areas are good locations for garbage receptacles because of the easy access.

Access for Haulers—Trucks and other vehicles used to move garbage within or out of the port must have access to garbage receptacles. Road access and road conditions leading to the port and to all berths within the port should be considered when locating garbage receptacles. It may be necessary to improve roads to increase accessibility and to prevent litter from falling off vehicles. Right of access to the port may need to be obtained for vehicles used to transport garbage. Weight limitations on the wharf may indicate use of a water-based collection system or strengthening of the wharf.

Lighting—When a designated reception area is employed, i.e., garbage reception facilities are in place at all times, the area should be well-lit to encourage 24-h use.

Security—Garbage reception areas must be secure to prevent abuse or misuse of the facilities and to ensure

the safety of seafarers and port personnel using them. A compound or environmental shelter may be used to physically and visually shield the containers, discourage use by unauthorized persons (e.g., local citizens who are not port users), and prevent garbage from blowing away.

Visibility—Garbage reception areas must be clearly marked and easily located. Directions should be posted within the port. Individual garbage receptacles must be clearly marked if they are to be used only for specific types of waste.

Impact on Surrounding Community—The expected impact of garbage reception facilities on the surrounding community should be considered as part of the site selection process. For example, light, noise, and odors may have an adverse effect on residences or businesses adjacent to the port. Complaints about objectionable aspects of the garbage reception facilities can be avoided by considering their effect on neighbors before implementation and making adjustments as necessary.

Federal, State, Local, and Other Applicable Laws—Garbage reception facilities must be located and managed to conform to Federal, State, local, and other applicable laws. Required permits or licenses concerning garbage handling must be obtained (33 CFR 158.410(a)(6)).

Handling—Typically, handling of Annex V wastes at a port involves either a land-based or a water-based system. Four examples of approaches are illustrated in Figure 7. As shown, hauling vehicles must be functional, but need not be elaborate. In the simplest approach, waste is simply collected and transported for final disposal. More involved schemes include collection, separation of recyclable materials, on-site treatment, and/or on-site storage before the wastes are transported for final disposal.

Land-based Handling—In a land-based system, garbage is either collected in a receptacle brought to the vessel, collected in receptacles at a site designated for waste collection, or offloaded directly to a hauling vehicle. Depending on the size of the port, stationary receptacles are placed in one central location or at multiple sites.

Receptacles brought to a vessel to collect garbage are mobile and require a storage area when not in use. The storage area should be close enough to the wharf to facilitate prompt delivery of receptacles when needed, but must not interfere with other port operations. The wharf must be large enough for the receptacle, even on a temporary basis, without interfering with other port activities, and must be sturdy enough to hold the vehicles used to transport the receptacles to and from the vessel.

If trucks or other vehicles are used to collect garbage offloaded directly from vessels, they require clear and readily available access to the vessels. Roll on–roll off vessels allow a garbage collection truck to be driven directly onto the vessel. For other types of vessels, the garbage collection vehicle drives as close as possible to the vessel and the garbage is offloaded onto the vehicle. This type of collection approach requires a good road system within the port, and wharves which are sturdy enough to support the vehicles. If logistics are arranged well, no parking within the port is needed for vehicles waiting to collect garbage from vessels. Otherwise, parking for garbage collection vehicles must be provided.

Water-based Handling—In a water-based approach, garbage is offloaded from vessels directly to a watercraft, typically a barge, self-propelled landing craft, or harbor tug. The collection watercraft may approach the vessel or, if the vessel is small enough, it may go to the watercraft to offload. This system is an effective alternative when the road system limits access to the wharf or when the jetties are not sturdy enough to support land vehicles.

Provisions must be made on the collection watercraft to prevent garbage from blowing into the water during transfer to and from the watercraft and during transport. In the United States, transport of municipal and commercial garbage by vessel, as well as loading and unloading operations, are covered by the Shore Protection Act. Covered containers, sealed plastic bags, tarpaulins, and nets over the garbage may be used to prevent garbage from blowing into the water.

Equipment may be required to lift empty waste receptacles onto a vessel and to remove them after they have been loaded. Lifting equipment may also be necessary when bagged garbage is removed directly from a vessel. When garbage is collected by a watercraft, it will be offloaded to land at some point for hauling to an incinerator or landfill. Some provision must be made for offloading the garbage either in the port at which the garbage is collected, at the disposal site, if it is accessible to the watercraft, or at another port.

On-site treatment and storage—On-site treatment and temporary storage of garbage are sometimes part of a port's waste management system. In this case, appropriate space must be set aside for these activities. On-site treatment sometimes occurs at the collection receptacle, e.g., compacting dumpsters both collect and compact garbage. Alternatively, garbage may be collected from various points within a port and taken to a central location for compacting or baling. Temporary storage areas should be accessible to vehicles used to collect garbage and to haul it from storage to an incinerator or landfill. For public health and safety and for aesthetic reasons, storage areas should be protected from wind and other weather and from foraging animals.

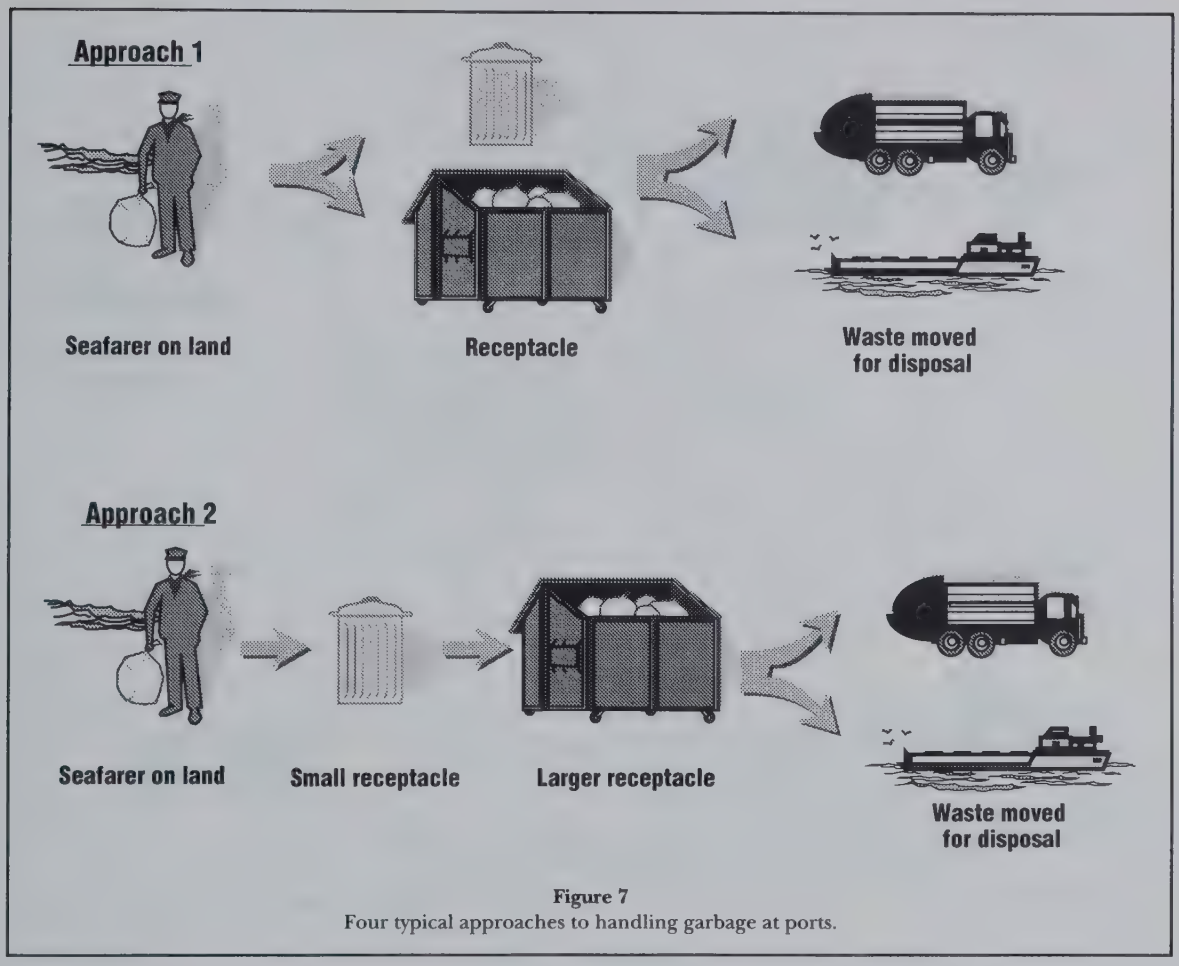


Figure 7
Four typical approaches to handling garbage at ports.

Appropriate sites for garbage receptacles include wharves adjacent to moorages, access points to docks, fuel stations, and boat launching ramps.

Improving an Existing System

Minor Adjustments

Port capacity for receiving and handling solid waste can be changed in a number of ways: by adding receptacles, increasing or decreasing the size of receptacles, compacting wastes, increasing frequency of garbage pick up, and diverting recyclable materials to a recycling program.

The siting of a garbage reception facility may be changed, for example by establishing a centralized collection area.

Features such as windscreens or shelters can be added to receptacles. Access can be improved by adding lighting or signs, or by increasing the visibility of receptacles.

Taking a New Approach

It may be decided to change the port's fundamental approach to solid-waste management. This will entail reassigning responsibility for receipt, handling, treatment, and disposal of garbage (Fig. 5).

Notification of Personnel and Users

Port personnel and users must be made aware of any changes in the solid-waste management system. Personnel should be informed of any changes prior to their implementation, and should understand the changes so that they can answer questions from port users.

Port users must be informed so that they can properly use the reception facilities. Techniques used to inform port users of changes in the waste management system have included port newsletters, bill inserts, spe-

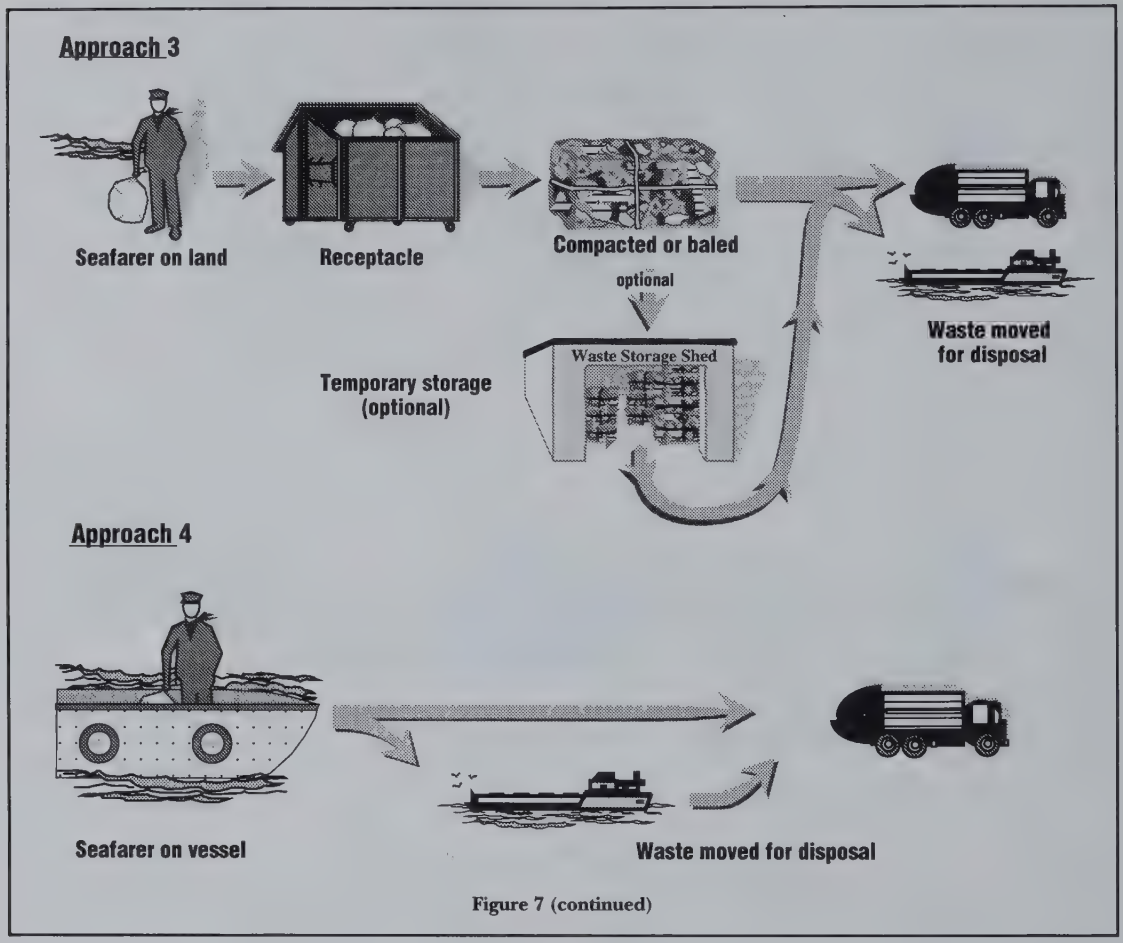


Figure 7 (continued)

cial mailings, notices throughout the port, and word of mouth.

Periodic Re-evaluation

The person in charge of solid-waste management for the port should conduct a periodic re-evaluation of the waste management system. Adjustments may be needed to respond to changes in port users, changes in the state of marine waste handling, problems with operations and equipment, or changing costs. Records of costs, labor time, volume of garbage handled, and user compliance before and after changes should be compared to aid in evaluation.

Chapter 3
Recycling as Part of a Garbage Reception Facility

Introduction

This chapter discusses port-based collection systems for Annex V waste that may be recycled or reused, and offers a detailed guide to planning and implementing such a system.

Recycling is the process in which materials otherwise destined for disposal are collected, reprocessed, or remanufactured, and then repurchased or reused by the consumer. Appropriate materials, called recyclables, retain useful physical or chemical properties after serving their original purpose. Recycling decreases the need for raw materials by reusing or remanufacturing materials otherwise destined for landfills, dumps, or incinerators, and shifts valuable resources back to manufacturers. Port-based recycling programs include only the collection and transfer or sale of recyclable materials.

Benefits to Ports

A well-planned and executed collection system for recycling provides both tangible and intangible benefits to a port. Recycling reduces waste dumping and the attendant disposal fees, since the port is typically charged each time a container of refuse is emptied. The more material that is identified as recyclable and sorted out of the waste stream, the less waste there is that requires disposal.

Recycling may also bring earnings from the sale of recyclable materials to markets or end users, offsetting waste-disposal costs. These earnings may be earmarked for special purposes; for example, one port uses recycling earnings for landscaping, and another uses them to fund parties for port personnel. Recycling makes good business sense.

Recycling can also improve public relations with both the larger community and individual port users. A good recycling program can reduce litter at a port, both in the water and on shore, making the facility more attractive to users. Concern about the environment is evident in many communities, many of which have mandatory recycling programs, and many commercial and industrial facilities now participate. Recycling also gets port users directly involved in port waste-management issues. A port with effective waste management, including a good recycling program, can be seen as part of the community's overall waste management system.

Issues for a Port-Based Recycling System

Insights on planning, implementing, and operating a successful program can be drawn from existing port-based recycling systems. Most such programs were started in an effort to offset the rising cost of garbage disposal. Some of the lessons learned from these programs are outlined here.

Support from Port Management

A recycling program must have complete support from port management during the planning phase. Without management support, there will be limited incentive to follow through with the program.

Cooperation With Local Government and Businesses

Contact should be made with local officials and companies to establish good working relationships and to determine whether a port-based recycling program will interfere or compete with existing programs. Efforts may include:

- Discussion with local officials about the port's needs and interests.
- Identification of any existing recycling programs.
- Interaction with any existing programs that provide residential recycling services, to ensure that the proposed port-based recycling program will not conflict.
- Contact with refuse haulers and commercial recyclers to discuss specifics such as sorting requirements, signage, equipment, and fees.
- Formation of an advisory committee comprised of port personnel, port users, local officials and business representatives, and volunteers to gain their in-

put and to make sure that the program will be workable for all. The advisory committee can also provide public relations and education support.
- Obtaining a firm commitment to the port recycling program from the port management and local officials. It may be better to delay recycling rather than allow the program to fail due to neglect.

Personnel

An enthusiastic and well-informed staff is essential for a successful program. The program must be headed by a committed individual who is knowledgeable about recycling markets and other aspects of recycling programs and who is willing to go out and "work the docks" to inform port users, port staff, and others about the necessity and value of the program. At a minimum, personnel requirements are:

- One individual responsible for the program. A staff person or reliable volunteer may be assigned to coordinate the planning, implementation, operations, and ongoing evaluation of the program.
- A designated recycling coordinator who will meet regularly with port staff to discuss the port's recycling program, including posing options for improvement, answering general questions, and obtaining staff commitment and cooperation.
- Monthly or quarterly reports of progress and goals, including quantities of materials recycled and associated costs and benefits, issued by the recycling coordinator. Staff members, management, and port users will see the results of their efforts and, hopefully, develop pride in the program.

Identification of Recyclable Materials

There is a tendency to think in terms of "the recycling market" as if there were only one market for recyclables. In reality, there are many markets for specific types and grades of recyclables. The recycling coordinator must identify which materials will be consistently accepted in the local recyclables market before the port collection program is initiated. The recycling coordinator must also understand the logistics of collection and handling and exercise the necessary quality control so that port-collected recyclables meet market and industry specifications. It is far better to start slowly, collecting a few recyclable items consistently, than to confuse participants with a complex and inconsistent program.

The amount and types of recyclable materials collected at a given port vary over time, depending on the size and type of port, local recycling markets, and time of year. Flexibility must be designed into the port collection, handling, and delivery systems to accommodate unavoidable fluctuations.

Equipment

At a minimum, a recycling program will have some well-marked collection area(s) and container(s). Containers will vary in size and type, depending upon the size of the port, the type of material being collected, and transportation issues. Other equipment which may be required includes windscreens and shields to improve aesthetic concerns, carts, hoists, and forklifts. If the recycling compound and the containers are not properly marked and located, the collection system may not be used.

Labor

The labor required for a collection system for recycling will vary depending on the size of the port. Recycling and waste-handling duties may be only a part of one person's responsibilities. Volunteers may also provide labor.

Public Relations and Education

Good public relations and education are crucial factors for a successful port-based recycling program. All port users must be informed of the existence, purpose, and proper use of the recyclables collection system. Education programs should focus on the reasons for and benefits of recycling, as well as on specific procedures used in the port. Convenient, highly visible, and clearly signed reception facilities are essential to raise and maintain public awareness. A recycling hotline (or even an answering machine with prerecorded information) can be used to disseminate up-to-date program information and to receive comments, suggestions, and complaints from port users. Port users may contribute ideas for improving the facilities, and if their input is used, they are more likely to participate in the program. Frequent and positive media attention to the efforts of the port and port users, the reduction of disposal costs, and the amount of materials being recycled will increase participation in the program and reduce potential opposition.

Planning and Implemention

A successful collection system for recyclable materials must be well-planned and well-executed. Figure 8 is an

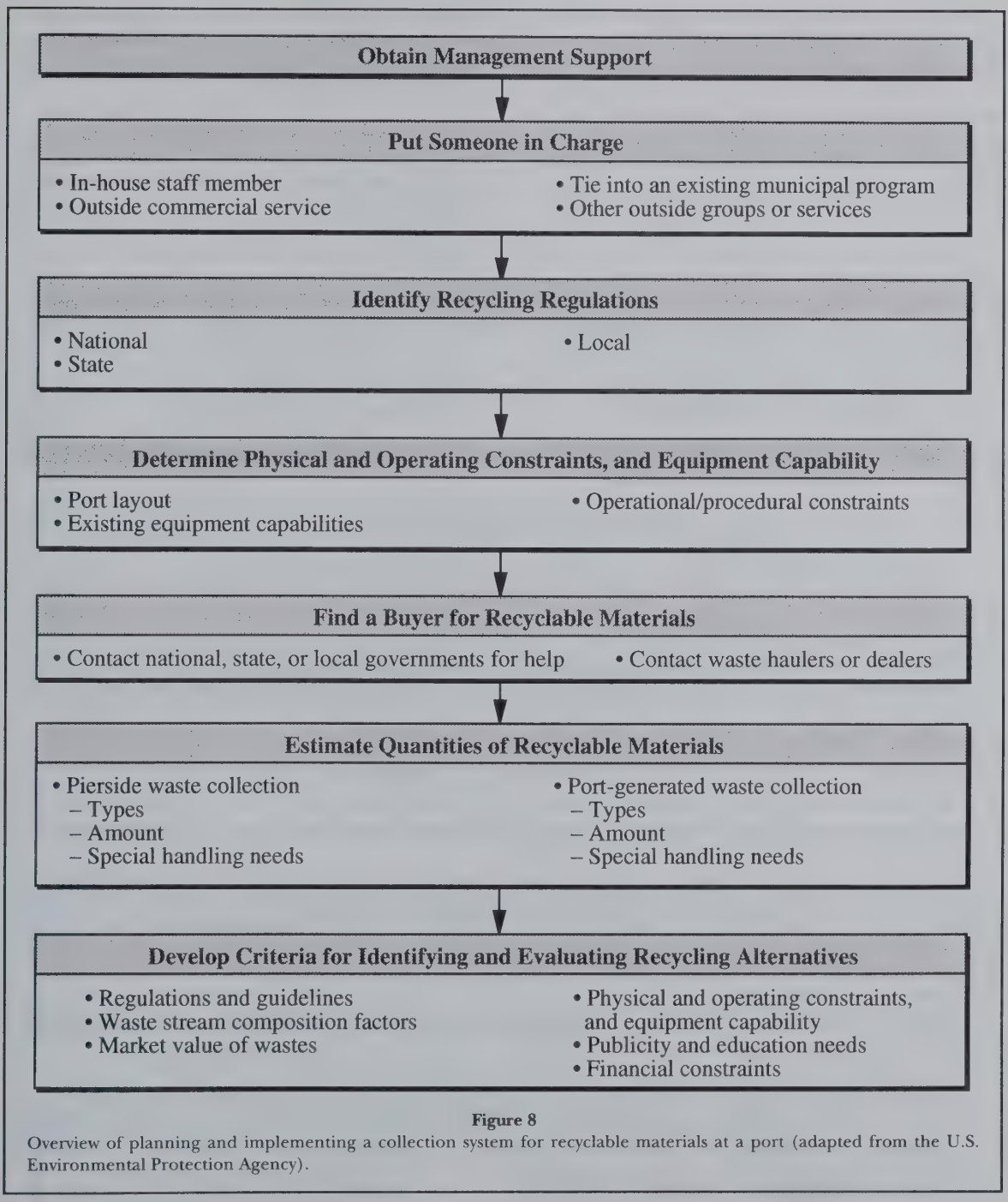

Obtain Management Support
Put Someone in Charge
• In-house staff member
• Outside commercial service
• Tie into an existing municipal program
• Other outside groups or services
Identify Recycling Regulations
• National
• State
• Local
Determine Physical and Operating Constraints, and Equipment Capability
• Port layout
• Existing equipment capabilities
• Operational/procedural constraints
Find a Buyer for Recyclable Materials
• Contact national, state, or local governments for help
• Contact waste haulers or dealers
Estimate Quantities of Recyclable Materials
• Pierside waste collection
– Types
– Amount
– Special handling needs
• Port-generated waste collection
– Types
– Amount
– Special handling needs
Develop Criteria for Identifying and Evaluating Recycling Alternatives
• Regulations and guidelines
• Waste stream composition factors
• Market value of wastes
• Physical and operating constraints, and equipment capability
• Publicity and education needs
• Financial constraints

Figure 8
Overview of planning and implementing a collection system for recyclable materials at a port (adapted from the U.S. Environmental Protection Agency).

overview of one approach to this process. The process will be the same for all types of ports, although the effort required at each step will vary according to circumstances. In some cases, the planner for the collection system (hereafter called the recycling coordinator) may find a formal, structured approach is neces-

sary; in other cases, less structure may be needed. The approach should be adjusted to the situation.

Administration

Management Support—To be successful, a collection system for recyclables must have complete support from top management, including financial decision-makers. Management must understand the benefits of recycling and how it can fit into the general solid-waste management program. Management must understand and support the following principles:

- A collection system for recyclable materials is only one of three parts of recycling. The others, manufacturing and consumer purchasing, will not be part of a port's program.

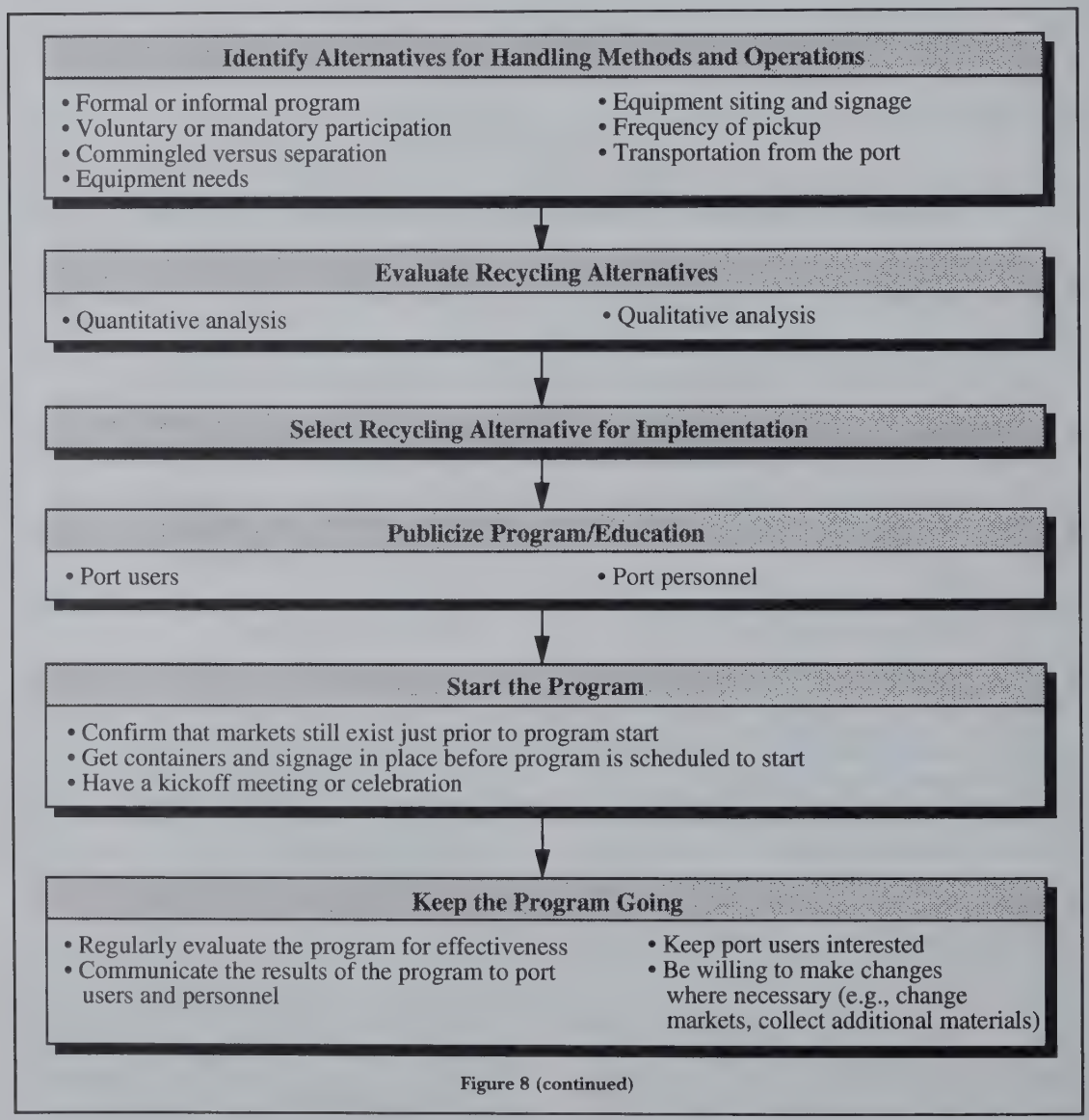

Identify Alternatives for Handling Methods and Operations
• Formal or informal program
• Voluntary or mandatory participation
• Commingled versus separation
• Equipment needs
• Equipment siting and signage
• Frequency of pickup
• Transportation from the port
Evaluate Recycling Alternatives
• Quantitative analysis
• Qualitative analysis
Select Recycling Alternative for Implementation
Publicize Program/Education
• Port users
• Port personnel
Start the Program
• Confirm that markets still exist just prior to program start
• Get containers and signage in place before program is scheduled to start
• Have a kickoff meeting or celebration
Keep the Program Going
• Regularly evaluate the program for effectiveness
• Communicate the results of the program to port users and personnel
• Keep port users interested
• Be willing to make changes where necessary (e.g., change markets, collect additional materials)

Figure 8 (continued)

- The collection program for recyclables will falter and eventually fail without management support.
- Time, staff, and, at least initially, financial support must be established for the program. Someone must be responsibile for the program.

The Recycling Coordinator—Management can usually either assign responsibility for the program to an in-house staff member, or hire an outside commercial service.

A port staff person whose job description specifically includes recycling may be assigned. Recycling and other waste-management issues may be this person's entire job, or just part of it. This person, the recycling coordinator, will be responsible for the entire program, including researching recycling options, planning and implementing the program, and, usually, conducting the day-to-day operations, as well as working with port users to ensure proper waste handling. The coordinator will also be responsible for identifying and correcting problems with the program on an ongoing basis.

Alternatively, a port may contract with a commercial waste handler to design and operate a program for recyclables collection. For facilities such as marinas and commercial fish houses, this may be more cost-effective, less labor intensive, and more convenient. An experienced commercial recycler can set up a system quickly using pre-existing equipment and service arrangements. It may also be possible for a port to expand its existing waste-disposal contract to include recycling services.

If a commerical waste handler is hired to design and conduct a recycling program, the port will still need to assign a staff person to coordinate with the commercial service and to work with port users to ensure proper waste handling.

Cooperative Arrangements—Another option may be to tie into an existing municipal recycling program, and this may be an inexpensive way to proceed. Or, it may be possible to make cooperative arrangements with a nearby municipality to utilize the same recycling markets.

Governments, universities, corporations, non-profit groups, and development assistance programs are sometimes willing to set up and operate recycling programs. If port management chooses to join such a program, the port will still need to work with port users to answer questions and help to solve problems. The success of the program will, however, depend on people outside the control of port management.

Regulations and Policy

One of the first steps for the recycling coordinator in planning and implementing a port-based collection system for recycling is to develop an understanding of the regulatory and policy context. Federal, state, and/or local regulations and policies may affect the operation of the program. The recycling coordinator who is not already familiar with these regulations and policies will need to contact federal, state, and/or local environmental protection agencies, waste management departments, or their equivalent, for assistance in identifying regulatory and policy requirements for recycling programs. A recycling system at a port will often fit into the integrated waste management strategy for the local area.

Once the relevant regulations and policies have been identified, it may prove useful for the recycling coordinator to talk with those government officials who implement them. Such interviews can clarify the regulations and policies and afford a better understanding of their practical workings. It may be useful to summarize the regulations and policies in tabular form. They must be considered in developing and evaluating recycling alternatives.

Physical and Operating Constraints

The recycling coordinator must know the port layout, what equipment capability is available, and the port's operations and procedures. The coordinator should obtain or develop a map of the port, inventory existing equipment, and develop an understanding of port operations and procedures through observation, interviews, and port documents.

It is important for the recycling coordinator to have first-hand knowledge of how wastes are handled from vessels docked for some period of time, from vessels docking after a voyage, and from the port itself. One way to do this is to follow or "walk" the journey of the waste stream. In this way the coordinator will develop an understanding of collection procedures and will identify physical and other constraints to implementing a recyclables collection system. Suitable equipment storage areas that do not interfere with port operations should be identified or located, and the space available for the installation of storage, collection, and transfer areas should be considered.

Marketing Recyclable Materials

The market value of recyclable materials will influence the design of a recycling program. Other influential factors include the existence of secondary markets, preprocessing requirements, contract terms, and distance to markets. The recycling coordinator must find a buyer for each recyclable to be collected.

Buyers' offering prices for recyclables will depend on the quality of the materials as well as on expected transportation costs. Manufacturers that use recyclables as raw production materials generally pay premium prices if strict quality specifications are met. Scrap merchants and many middlemen often pay nothing for recyclables but will haul away separated, but otherwise unprepared, materials. A recycling coordinator who intends to sell recyclables must be aware of the manufacturers' requirements and design the program accordingly.

To identify markets for recyclables, the recycling coordinator can contact federal, state, and local environmental protection or waste management agencies, which often have information regarding markets for recyclable materials. Alternatively, waste haulers or dealers can be contacted directly. Commercial haulers often buy recyclable materials or can suggest appropriate end users. Buyers should be screened for their price policies, material standards, transportation costs, and contract requirements.

The value of recyclable materials often fluctuates, and the recycling coordinator must make provisions for disposal of recyclables when markets fail. Often, recyclable materials can be included in the general solid-waste disposal system.

Waste-stream Characterization

The types and amount of wastes and recyclables found in both vessel- and port-generated waste streams will have a direct impact on feasible recycling alternatives. To determine what recyclable materials are offloaded from vessels and generated at the port, the recycling coordinator should examine the waste stream for those materials.

Three methods for undertaking waste stream characterization are discussed in Chapter 2: the weight-based output, volume-based output, and input or materials flow approaches. A description of the weight-based output method of characterizing wastes, including equipment needs, precautions, and procedures, is presented here. Figure 9 outlines procedures for estimating quantities of recyclables by this method.

This discussion treats a waste stream generated by both vessels and port operations. Vessel-generated waste includes garbage from all shipping sources (e.g., commercial shipping, recreational boating, fishing, cruise vessels, and research vessels); port waste includes waste from offices, shoreside maintenance, and port tourists and visitors.

Equipment—The equipment required for characterizing the waste stream is modest. It will include:

- Labeled containers for the storage and measurement of waste samples. These containers should be waterproof both to protect the samples from rain and to retain any water content of the waste.
- A mechanical or electrical scale with capacity proportional to the waste to be weighed. To ensure accuracy, the scale should be calibrated according to the manufacturer's specifications or certified by the state agency responsible for weights and measures.
- Heavy-duty tarpaulins, shovels, rakes, push brooms, magnets, and a sorting table.
- First aid kit.
- Appropriate personnel safety equipment such as chemical-resistant gloves, safety glasses, aprons, and boots.

Precautions—Steps should be taken to protect the personnel who conduct the sampling. These may include (but may not be restricted to):

- Instruct personnel to avoid sharp objects, such as broken glass and razor blades, that might cause injury.
- Supply personnel with proper protective clothing.
- Instruct personnel not to open red plastic bags with biohazard labels.
- Instruct personnel to stay clear of dumping operations.
- Instruct personnel in safe sorting practices, for example, to sort by brushing through the sample with a spreading motion, rather than thrusting hands into the sample pile.

Procedures—It is important that a sampling plan is based on a valid statistical analysis of the specific situation at hand, in order to reach valid conclusions. The sample taken must be representative in every relevant way of the overall waste stream. It is advisable to seek the advice of a statistician regarding development of the sampling plan.

At the conclusion of sampling, it should be possible to accurately estimate the annual rates at which general and recyclable waste are generated. The sampling plan should identify such factors as the size and number of samples to be examined, the number and location of waste-collection containers to be sampled, the location of the wastes within the containers to be sampled, the categories by which specific waste-stream components will be identified and quantified, and the work calendar. Seasonal variations such as those which may occur with the beginning or end of a recreational boating season or the start of a commercial fishing season should be taken into account.

It will be necessary to develop a form to be used for recording and calculating the presence of different components of the waste stream. Figure 10 is an example of a form which can be used or adapted for this purpose.

Sorting and analysis is performed in three general steps:

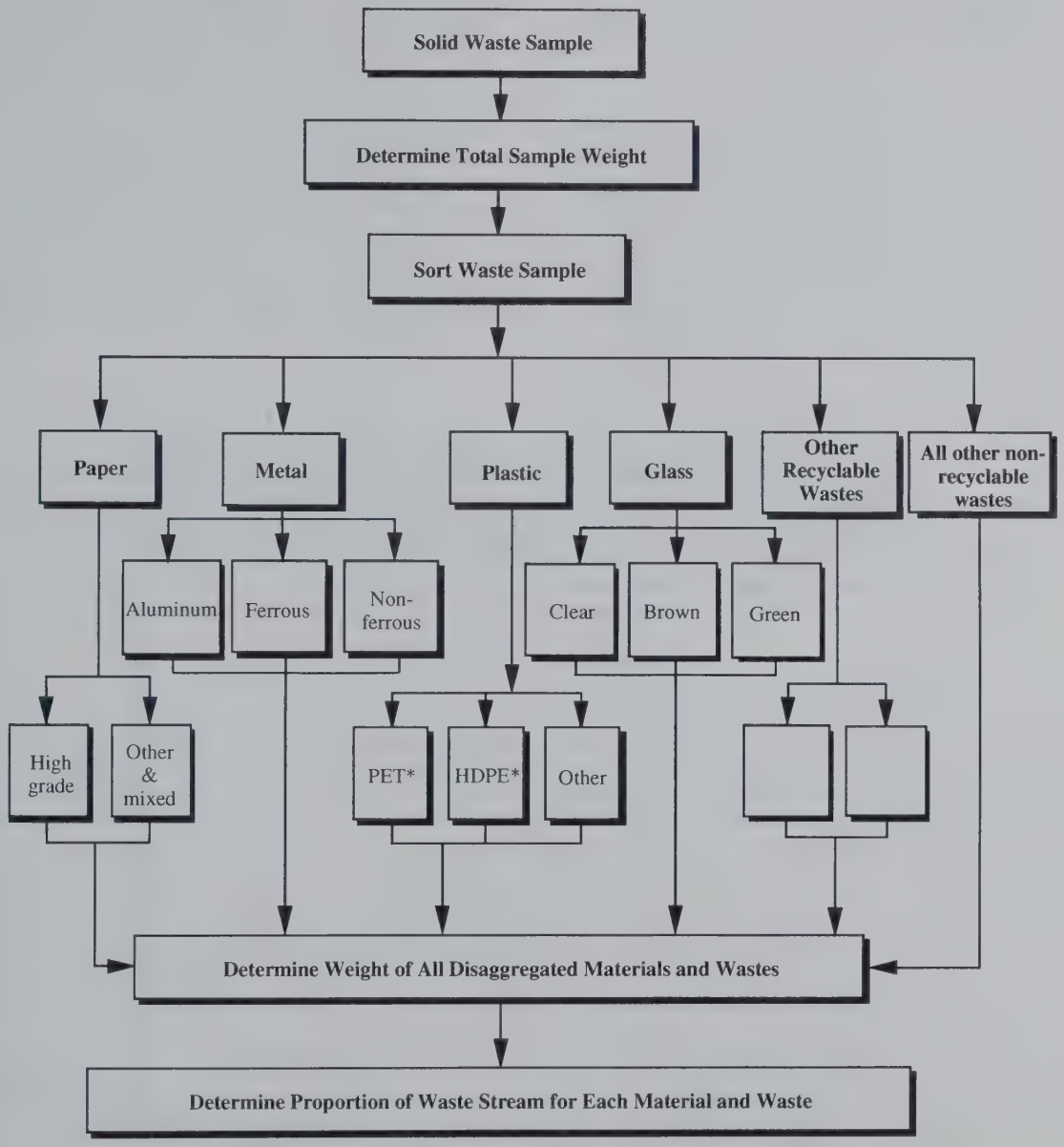


Figure 9

The weight-based output method for estimating quantities of recyclable materials in the waste stream. *PET = polyethylene terephthalate; HDPE = high-density polyethylene.

1. Separation
   - Choose a clean, flat, level area with limited wind exposure for the sorting and weighing operations.
   - Position and level the scale.
   - Weigh the empty storage containers and mark them with their void (tare) weights.
   - Dump the selected samples onto the prepared surface.

- Separate the refuse into two categories: recyclables of interest, and all other materials. Recyclables will be of interest only if they have worthwhile market value. For example, disposable razors are recyclable plastic items but do not have the market value of high-density polyethylene containers. If an insufficient amount of a particular type of recyclable is available at a port, or the recycling market is restricted to specific items, it may not be profitable or possible to recycle a particular material. The feasibility of meeting special handling requirements for recyclable materials must also be considered.
- Within the recyclables category, separate the sample into groups according to material. Typical recyclable materials include paper, plastics, metals, and glass. In fishing ports, fishing nets may be included. Each material group should be sorted into recoverable resource types according to their value. Paper may be separated into glossy, brown, office stock, corrugated board, newspaper, etc. The material types will depend on the requirements of the recycling market. For example, if the current market will accept commingled clear, brown, and green glass, glass waste need not be separated by color.
- Continue sorting until particle sizes of 1.0 centimeter or smaller are left. If refuse cannot be separated into categories, it should be placed in the other (non-recyclable) waste category.

Waste Resource Category	Material Class	Recoverable Resource Sample				
		Type	Total Weight (Column A)	Container Weight (Column B)	Net Weight (Column C)	Percent of Total (Column D)
Recyclables	Paper	Office paper	____	____	____	____
		Newspaper	____	____	____	____
		Corrugated cardboard	____	____	____	____
	Plastic	High-density polyethylene	____	____	____	____
		Polyethylene terephthalate	____	____	____	____
		Other plastic	____	____	____	____
	Glass	Clear	____	____	____	____
		Brown	____	____	____	____
		Green	____	____	____	____
	Metals	Aluminum cans	____	____	____	____
		Ferrous	____	____	____	____
		Non-ferrous	____	____	____	____
	Other (e.g., fishing net)		____	____	____	____
All other non-recyclable wastes			____	____	____	____
Total			____	____	____ (Box E)	100%

Figure 10
Example of a form which can be used to record the presence of different components of the waste stream and to calculate their percent frequency.

2. Weighing the Samples
   - Each separate category of waste and recyclables must be weighed and recorded. If the form shown in Figure 10 is used, the net weight of each category (column C) is determined by subtracting the weight of the empty container (column B) from the weight of the container with the waste (column A).
   - The total weight of the waste sample is determined by adding the weights of all categories (column C). Enter this weight in Box E of the form.
   - Divide each entry in column C by the total in Box E. This will yield a percentage by weight of each type of waste, which should be entered in column D.

3. Calculation of Waste Generation Rate
   The rate at which waste is generated, or generation rate, is measured in pounds per person per day. Converting data to this sort of standard measurement unit is called normalization. In the case of waste generated on board a vessel, generation rate is calculated by adjusting for the number of seafarers, the number of days waste was generated, and the size of the sample, using the following equation:

$$R = \frac{w/n}{s \cdot t}$$

where R = generation rate per seafarer per day,
w = weight of the sample,
n = number of seafarers,
t = period of waste generation (in days), and
s = sample scope (size of waste sample as a proportion of all waste generated during a period)

Table 2 is an example of this process of normalization for samples of recyclable materials. The same steps can be used to determine generation rates of waste and recyclables from port operations, in terms of pounds per personnel (or employee) per day.

Generation rates from municipal solid-waste studies can be used to test your results for reasonableness and to identify ways in which the port differs from other waste generators. Figure 11 shows percentages of materials by weight in the solid waste stream for all municipalities in the United States.

Based on an evaluation of type, amount, and special handling requirements of recyclable materials in vessel-generated garbage offloaded in port and in port-generated garbage, the recycling coordinator must select which, if any, recyclable materials are appropriate for collection at the port. If market arrangements do not exist, or necessary storage or processing cannot be accommodated, a material should not be designated for collection.

Development of Program Criteria

After identifying the types of material which can be recycled through the port, the recycling coordinator will develop criteria for evaluating recycling alternatives. The criteria should be organized according to

Table 2
Examples of calculating rate of waste generation for different waste materials generated by Vessel 1 in port for 3 days, and by Vessel 2 at sea for 8 days.

Variable		Vessel 1 HDPE[1]	Vessel 1 PET[2]	Vessel 2 High-grade paper	Vessel 2 Mixed paper
W	Weight of total waste generated (kg)	7	4.75	127	326
n	No. of seafarers	25	25	223	223
$\frac{w}{n}$	Weight/seafarer (kg)	$\frac{7}{25} = 0.28$	0.19	0.57	1.46
t	Period of waste generation (days)	3	3	8	8
s	Sample size (% of all waste)	100%	100%	23%	23%
$(s \cdot t)$	Normalized period of generation (days)	3.00	3.00	1.84	1.84
$R = \frac{w/n}{(s \cdot t)}$	Rate of waste generation (kg/seafarer/day)	$\frac{.28}{3.0} = 0.09$	0.06	0.31	0.79

[1] HDPE = High-density polyethylene.
[2] PET = Polyethylene terephthalate.

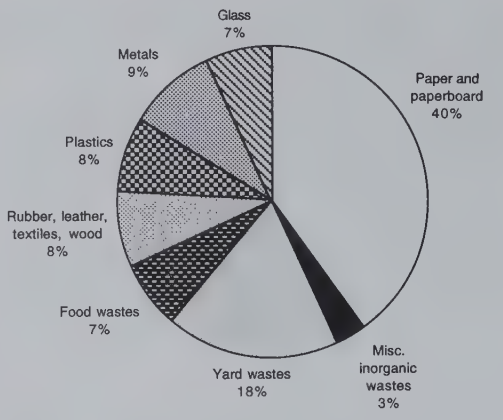


Figure 11
Percentages of materials by weight in the solid-waste stream of United States municipalities, 1988 (data from the U.S. Environmental Protection Agency).

categories, which might include: regulations and guidelines; waste stream composition; market value of wastes; port physical constraints, equipment capability, and operating constraints; public relations and education requirements; and financial constraints. These are discussed briefly below.

Regulations and Guidelines—The summary of the regulatory requirements and policy directives completed earlier in the planning process should be used to identify constraints that will affect a recycling program. The regulating entities that will influence a port-based recycling system will depend on the circumstances, but they could include MARPOL Annex V and its national implementing legislation, and federal, state, city, town, and local governments. A port-based collection system for recycling should strive to meet or exceed the requirements from all applicable regulating entities. A table of regulations may be used to identify the most stringent of each entity's regulations. Such a table will list each facet of a collection system for recycling, with the corresponding requirements of each relevant regulatory entity. The most stringent guideline in each area should be incorporated into the program design specifications. An example of a format for a regulatory matrix is presented in Figure 12; this may be adjusted according to circumstances.

Waste Stream Composition—The types and amounts of wastes and recyclable materials found in the waste streams from vessels and from the port will have a direct impact on what recycling alternatives are feasible. If volumes of recyclables are large and a steady flow is expected, then alternatives may include substantial investment in infrastructure or contracting for infrastructure, to take advantage of economies of scale. If volumes are low or intermittent, then large capital expenditures and a formal program will not be feasible, but an informal program may serve well.

Market Value of Wastes—If the collection system is large enough, a financial analysis of projected revenues and/or savings may be needed. The research on markets for recyclables can be used to develop forecasts of what revenues can reasonably be expected. This information is a valuable quantitative addition to the largely qualitative process of deciding which recycling program alternative to select, providing a gauge of the cost of each alternative. Costs of transportation and equipment and avoided costs must also be considered.

Physical and Operating Constraints—Recycling alternatives must conform to the spatial limitations of the port, and equipment must be able to handle the quantities of recyclables expected. The information needed to determine physical, operating, and procedural constraints and equipment capabilities collected earlier in this process must be considered.

Publicity and Education—The amount of publicity and education needed for port users and personnel for each recycling alternative should be considered. Publicity and education efforts have financial implications for the program and will affect its success as well as the public image of the port. These should be decided by upper management.

Financial Constraints—There will certainly be limitations to funding and financial management resources, and these may constrain the development of recycling alternatives. Financial constraints will include limitations on capital investments and cost of program labor and administration. Such limitations should be incorporated into the criteria for recycling alternatives.

Identification of Program Alternatives

Once program criteria are established and, if necessary, accepted by management or program funding sources, alternatives must be identified. These may range from setting up a program for dockside collection (vessel wastes) or for port-generated wastes (restaurants, boat yards, other tenants) only, to developing an integrated program for dock and port wastes. Handling and operations may be undertaken by one or more of the following groups: port personnel, contractors, municipal personnel, and volunteers. Figure 13 provides a

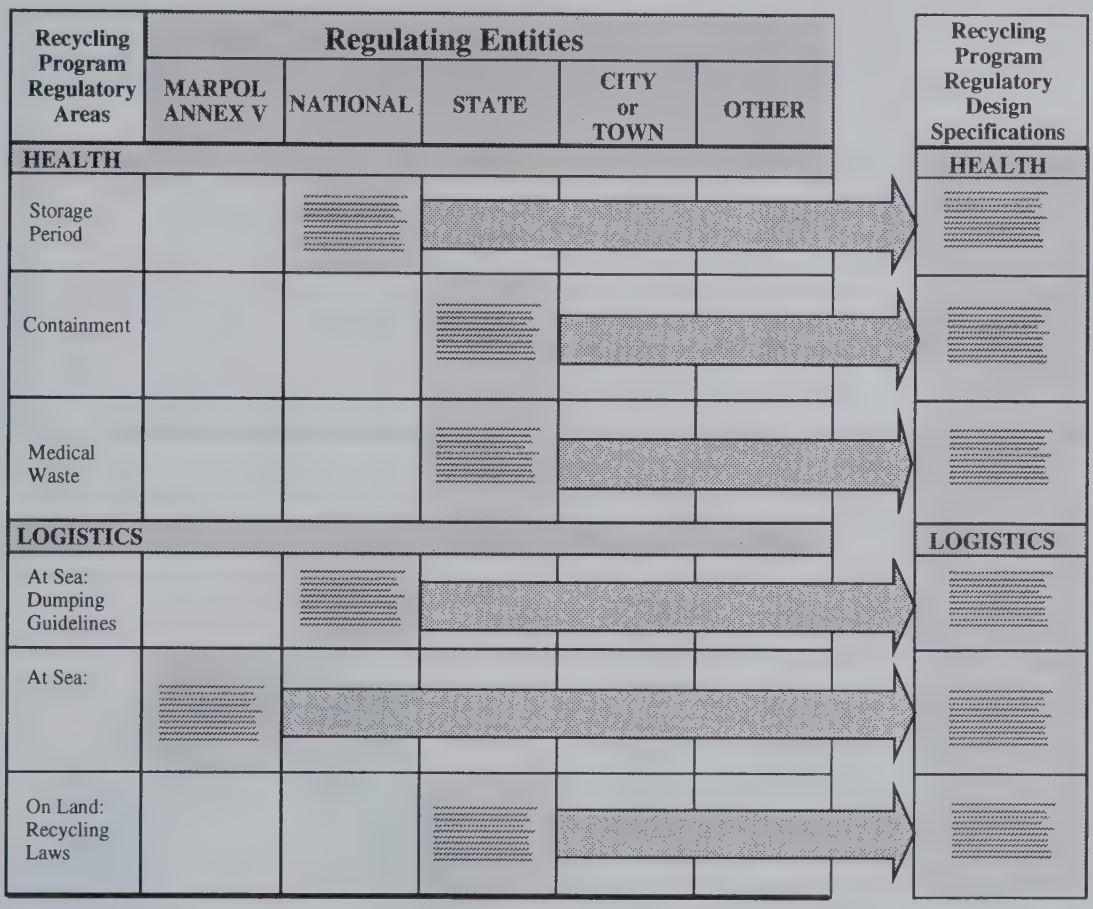


Figure 12
Example of how to use a table of regulatory specifications to formulate regulatory requirements for a recycling program.

form which can be completed for each alternative, to identify who is responsible for each part of a recyclables collection system.

Level of Program Formality—The choice must be made between a formal or an informal approach. A formal collection system for recycling would include the collection of materials and all other activities needed to get those materials to market. If market arrangements do not exist or the quantity of a specific material is too variable, a formal program for that material is not practical. In an informal program, a collection area is designated for reusable materials such as fishing net, wood, or cable, which are then made available at no charge to port users and community residents. The port will avoid disposal costs, if the materials are in fact taken for reuse. Even in an informal program, the recycling coordinator will need to designate a collection area and provide lighting and signage. In ports where this approach has been used, containers are provided for different materials, and a level ground area or pallet is provided for bulky items. The recycling coordinator should check the designated collection area periodically to make sure that the materials are in fact being taken, and make arrangements for their removal and disposal if they are not. The recycling coordinator may need to reevaluate the informal program periodically.

Obtaining Participation—Another consideration is whether participation in the program will be voluntary or mandatory. Mandatory participation may be difficult to implement. Ways to encourage participation in a

	Collection	Sorting	Processing	Transport to Market	Admin	Publicity/ Education
Contractor						
Port Personnel						
Municipal Personnel						
Volunteer						

Figure 13
Example of a form which may be used to chart personnel responsibilities for the operation of a recycling program.

voluntary program include imposing waste-disposal fees according to volume of waste; education and program promotion; and ease of use and access.

Degree of Material Separation—The recycling coordinator should explore the level of sorting to be required. The decision to accept commingled (mixed) recyclable materials or to require port users to separate recyclable materials into different containers will affect everything else about a recyclables collection system. This decision will be based on the existence of markets, market specifications, and market arrangements.

Equipment—Collection containers will be required, but they need not be elaborate or expensive—they just have to work. Containers will vary in size and type depending upon the size of the port, the type of material being recovered, transportation issues, and demand. Container size will affect the servicing schedule, as they must be emptied often enough to prevent overflowing. Inappropriate containers can jeopardize program success.

If the recycling containers too closely resemble garbage containers, port users will be confused and will contaminate recyclable materials with garbage. This problem can be minimized by using different types of containers for recyclables and garbage, as well as by signage. Containers for collecting recyclables should be marked with the universal "chasing arrows" recycling symbol (Fig. 14). Recycling containers may be further distinguished from garbage containers by painting the two types of receptables in very different colors.

Recycling containers must also be marked to indicate what materials are acceptable. Signs placed at eye level above the containers as well as markings on containers are essential. Depending on market conditions and regulations, it may be necessary to further indicate what items made from the material can be accepted. For example, plastic food containers, but not plastic beverage containers, may be acceptable. Posters and/or signs must be placed around the port both to show where to discard recyclable materials and to encourage participation.

Figure 14
The universal recycling symbol.

Recycling containers may include 55-gallon drums, fish totes, custom-built receptacles, and pallets for wood, metal, cable, and nets. Windscreens and shields may be needed to address aesthetic concerns; carts, hoists, forklifts, or other hauling equipment will probably be required.

Siting and Signage—Collection containers should be positioned for easy and convenient access by port users. Recycling containers should be placed near or adjacent to other garbage collection containers, which will help prevent recyclable materials from being contaminated with garbage. A designated "waste management area" for both garbage and recycling collection containers has been found to be effective. Another approach used at some ports is to position recycling and refuse containers at the head of the dock, with designated collection or stockpile areas for large items.

Frequency of Emptying—An appropriate emptying schedule will prevent container overflow and the resultant mess. If port users view the area as messy, they will associate it with refuse and tend to contaminate recyclables, which will then lose market value. Port users may also conclude that their efforts to recycle are wasted, and quit participating in the program.

Transportation From the Port—The buyer or end user will often pick up recyclable materials, or a port may be able to arrange with a waste collection service to haul recyclable materials for no charge or for a share of the profits. The port may also arrange to transport recyclable materials itself, or to have vendors or volunteers remove recyclables.

Evaluation of Alternatives and Selection of a Program

Once feasible recycling alternatives have been identified, the recycling coordinator must evaluate them on the basis of both quantitative (profit/loss) and qualitative considerations.

Quantitative Analysis—Financial benefits will include not only revenues from the sale of recyclables but also avoided disposal costs, which can be estimated as the cost of collection, transportation, and landfill disposal (or incineration) of a given weight or volume of waste.

If warranted by the potential size and complexity of a collection system for recycling, a model can be developed on a computer spreadsheet specifically for the quantitative portion of the evaluation. An example of such a model is shown in Figure 15. Variables which serve as inputs to the model will include:

- Participation/recovery rates expected for each segment of the recycling program (from vessels and from the port itself).
- Revenues based on recycled material prices, and savings from avoided costs.
- Transportation purchases and operating costs.
- Processing purchases and operating costs.
- Administration salaries and overhead costs.
- Publicity and education costs.

The spreadsheet model will yield the financial result of each alternative under evaluation. Sensitivity analyses can then be conducted to determine the effects of changes in each of the variables on the bottom line.

Qualitative Analysis—Because many benefits of recycling cannot be evaluated from a financial point of view, the evaluation of recycling alternatives should include a qualitative analysis. This will usually take the form of a discussion with a cross section of those affected by the potential collection system. This discussion may include the ultimate decision-maker for the program, port users, port personnel, and/or an advisory panel established for this purpose. A spreadsheet may be used to structure the presentation and discussion of alternatives (Fig. 16).

Selection of the Best Alternative—Next, the program to be implemented must be selected. The decision-making process will vary by situation. The recycling coordinator should combine the results of the quantitative analysis, if there is one, with those of the qualitative analysis, and recommend a preferred alternative. However, the decision on the alternative to be implemented may not rest with the recycling coordinator.

The collection system for recycling should have a quantitative goal by which program success may be evaluated. A goal of diverting 5% to 10% of the waste to recycling is not unreasonable for the first year of the program. After the first year, the recycling coordinator should reevaluate and adjust the goal based on the waste stream and on market conditions.

Publicity and Education

Once equipment and service arrangements for collection have been made, the recycling coordinator must inform port users and personnel about the new program. Personnel should be informed before port users, so that they can answer questions from users or direct them to those who can. An awareness campaign for port users should begin shortly before the start of the program. This campaign should explain how the program will work, where port users can ask questions about the program, and the benefits of recycling. If

port users do not know that the program exists or how it works, the program will fail. Of critical importance in building public awareness is signage and visibility of recycling containers. Also critical is direct contact between staff and port users. Consider assigning port staff to go from vessel to vessel during the first few weeks of the recycling program, explaining the program and its importance. Contact with users should be continued periodically after the program is running. Other successful publicity techniques include brochures, posters,

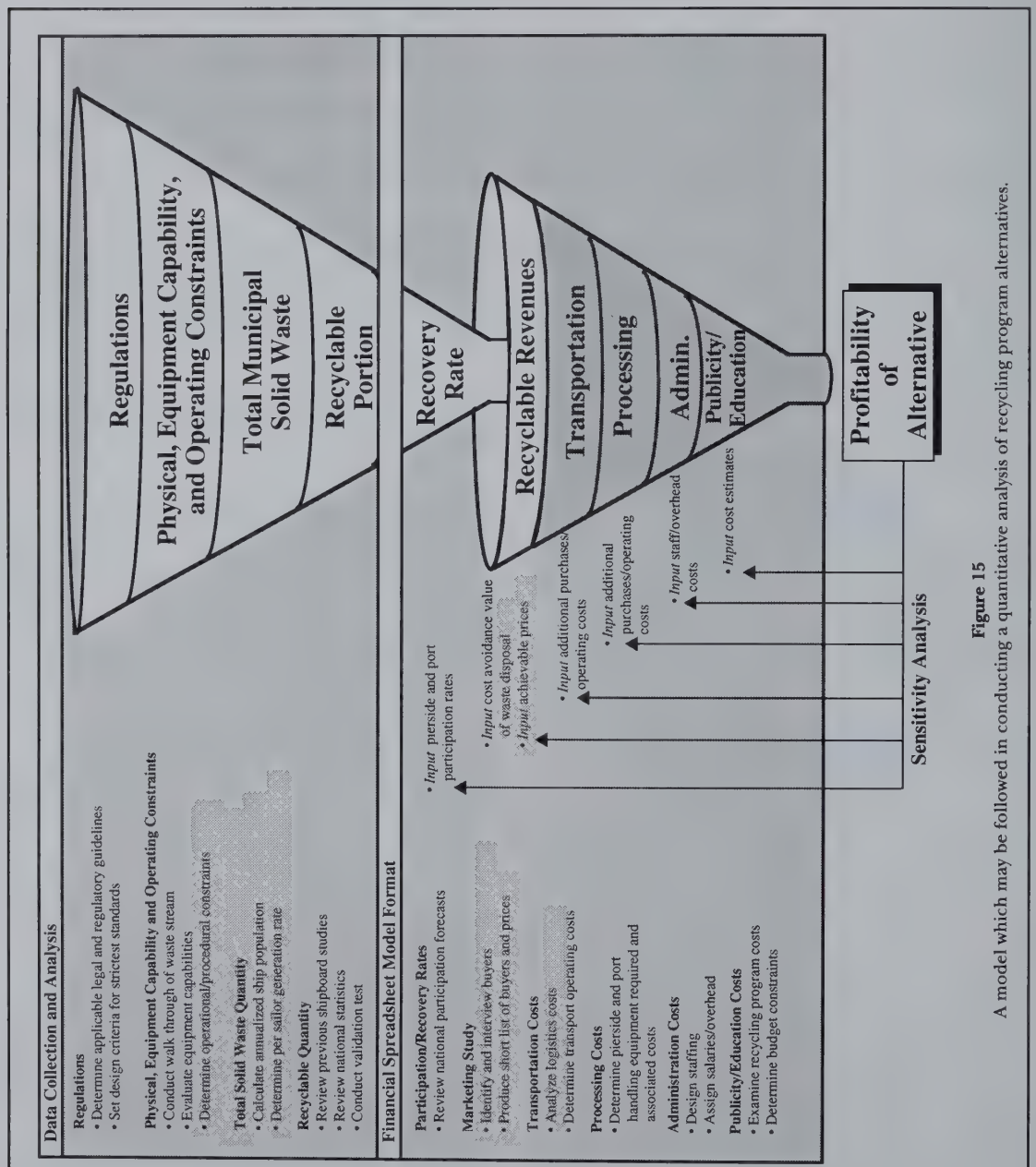

Data Collection and Analysis
Regulations
• Determine applicable legal and regulatory guidelines
• Set design criteria for strictest standards
Physical, Equipment Capability and Operating Constraints
• Conduct walk through of waste stream
• Evaluate equipment capabilities
• Determine operational/procedural constraints
Total Solid Waste Quantity
• Calculate annualized ship population
• Determine per sailor generation rate
Recyclable Quantity
• Review previous shipboard studies
• Review national statistics
• Conduct validation test
Financial Spreadsheet Model Format
Participation/Recovery Rates
• Review national participation forecasts
Marketing Study
• Identify and interview buyers
• Produce short list of buyers and prices
Transportation Costs
• Analyze logistics costs
• Determine transport operating costs
Processing Costs
• Determine pierside and port handling equipment required and associated costs
Administration Costs
• Design staffing
• Assign salaries/overhead
Publicity/Education Costs
• Examine recycling program costs
• Determine budget constraints
• Input pierside and port participation rates
• Input cost avoidance value of waste disposal
• Input achievable prices
• Input additional purchases operating costs
• Input additional purchases/operating costs
• Input staff/overhead costs
• Input cost estimates
Regulations
Physical, Equipment Capability, and Operating Constraints
Total Municipal Solid Waste
Recyclable Portion
Recovery Rate
Recyclable Revenues
Transportation
Processing
Admin.
Publicity/ Education
Sensitivity Analysis
Profitability of Alternative

Figure 15
A model which may be followed in conducting a quantitative analysis of recycling program alternatives.

decals, video tapes, port newsletters, and newsletter inserts listing port charges. In areas where port users are not generally transient, advertisements or public service announcements in local newspapers and on local radio stations have also been used. No matter how your publicity campaign works, be sure the recycling program is explained simply and directly.

Program Implementation

Immediately before the program is implemented, certain steps should be taken to help ensure program success. The recycling coordinator should:

- Re-confirm the planned buyers of recyclables and the arrangements for pickup and delivery to market. If market conditions have changed, it may be necessary to adjust the program before it begins.
- Make sure containers and signage are in place. The timing of placing containers and signage is important in getting a program off to a good start. If the containers are in place too long before the program starts, port users may get into the habit of using them

Qualitative Analysis Criteria	Alternative #1	Alternative #2	Alternative #3	Alternative #4
Recovery Rate				
Recyclable Revenues • End Users • Scrap Merchants				
Transportation • Port Supplied • Contractor Supplied • Other Supplied				
Processing • Time to Implement • Conformity to Existing Operations				
Administration • Auditing Methods • Operational Control				
Publicity/Education • Port Users • Dockside Personnel • Other Port Personnel • Public Relations Value				

Figure 16
Example of a spreadsheet approach to a qualitative analysis of recycling program alternatives.

incorrectly. Conversely, if containers are placed after the start of the program, port users will view the program as poorly designed. As a rule of thumb, containers and signs should be put in place no more than 2 weeks prior to the program's start.

- Conduct a kick-off event to mark the start of the port's recycling program. A meeting may be appropriate for a port where users are not transient. At a port with primarily transient users, festive decorations or a celebration may be appropriate to mark the start of the program. Coordinating the recycling program kick-off with an annual port or city event is a good idea.

Program Maintenance

It is not enough to simply start a collection system for recycling and expect it to run by itself. The recycling coordinator should:

- Regularly evaluate the program for effectiveness.
- Communicate the results of the program to port users, personnel, and management.
- Keep port users interested in the program.
- Make changes in the program where necessary.

No recycling program is static. The amount of recyclable materials collected can change; collection methods can prove ineffective; and markets for recyclable materials can fail or develop. The recycling coordinator must be prepared to change the program as warranted and then publicize the change. However, port management should commit at least 6 months to 1 year to the recyclables collection program regardless of early success or failure, in order for the program to have a chance to catch on.

Chapter 4
Costs of Waste Management

Introduction

Compliance with MARPOL Annex V by seafarers will result in the collection of greater volumes of garbage at ports. The size and location of ports, in addition to the types and numbers of vessels they service, affect the cost of solid-waste management operations. Labor and disposal costs vary significantly nationally and internationally, and play an important role in determining acceptable cost structures and disposal options.

Revenues generated by the port from fees and from recycling programs may be used to offset their costs. In addition, efforts to reduce the amount of garbage requiring disposal, including recycling, will reduce costs and will benefit ports, vessels, and the environment. This chapter discusses the costs of waste management and ways to avoid and to recover costs.

Expenses and Revenues

The net cost of waste management will be the sum of expenses to dispose of and to recycle wastes, minus revenues from recycled materials (Fig. 17). The port may wish to offset this amount through fees charged to vessels or by generating other revenue. Waste management expenses include the cost of equipment and labor for collection, treatment and storage, transportation, and disposal (Fig. 17).

When recycling is part of the solid-waste management strategy, the costs and revenues associated with recycling must be calculated when determining the total cost of waste management. Recycling costs will include equipment rental and transportation. There will be either recycling fees, or revenue from the sale of recyclable materials. The net waste disposal cost avoided due to recycling will be based on the amount (tonnage) of waste diverted from disposal, and is calculated as a recycling revenue (Fig. 17).

Reduction of waste generation, and hence management costs, is viewed as the preferred alternative in waste management. Recycling can be used as a method of reducing waste by ports in the same way that it is used by municipalities.

Cost avoidance also affects total cost. Simple cost avoidance strategies include the use of readily available port or industry-related equipment such as wooden tote boxes, barrels, or used shipping containers for garbage collection, separation, and storage. Recycling costs to the port may be minimized by integrating port collection with an existing municipal collection program, although a system for cost and revenue sharing must be devised. Some discarded items, for example, fishing net in some communities, are highly sought after for unrelated uses such as wall decorations and sports equipment. Disposal costs can be avoided simply by making such items available to the general public.

Recovery of Waste Management Costs

Although ports in the United States are required to provide adequate reception facilities for ships' garbage, they may recover the costs of doing so; however, there is no mandate for how this is done. No single means of cost recovery will be suitable for all ports, nor is any port limited to a single means.

It is important that port disposal fees are not prohibitively high, since illegal dumping of wastes at sea can be performed at no cost (until the violator is caught). In effect, high fees discourage compliance and provide no incentive for retrieval of debris from the ocean.

Disparities among the fees charged by competing ports may alter traffic patterns. In addition, the competitive position of a port may be affected by the fees it charges for garbage reception services. Ports must balance their legal obligations under MARPOL Annex V (as well as other obligations) with their business objectives. Fortunately, the simple directive in Annex V that ports provide adequate reception facilities for garbage is preserved in U.S. regulations that allow ports to meet this obligation in the most cost-effective way possible.

Costs associated with garbage reception facilities at ports are typically passed on to port users in one of two ways. Either the user is charged directly for the use of the service, or the costs are absorbed into general port charges. Some ports have a user fee for wastes, which is sometimes applied to all vessels regardless of whether or not they offload wastes.

The mechanism for recovering costs can influence the behavior of potential users of the port. For example, if direct charges are deemed too high, users may hold their garbage for disposal in ports with more reasonable charges, and have some incentive to illegally dump their garbage at

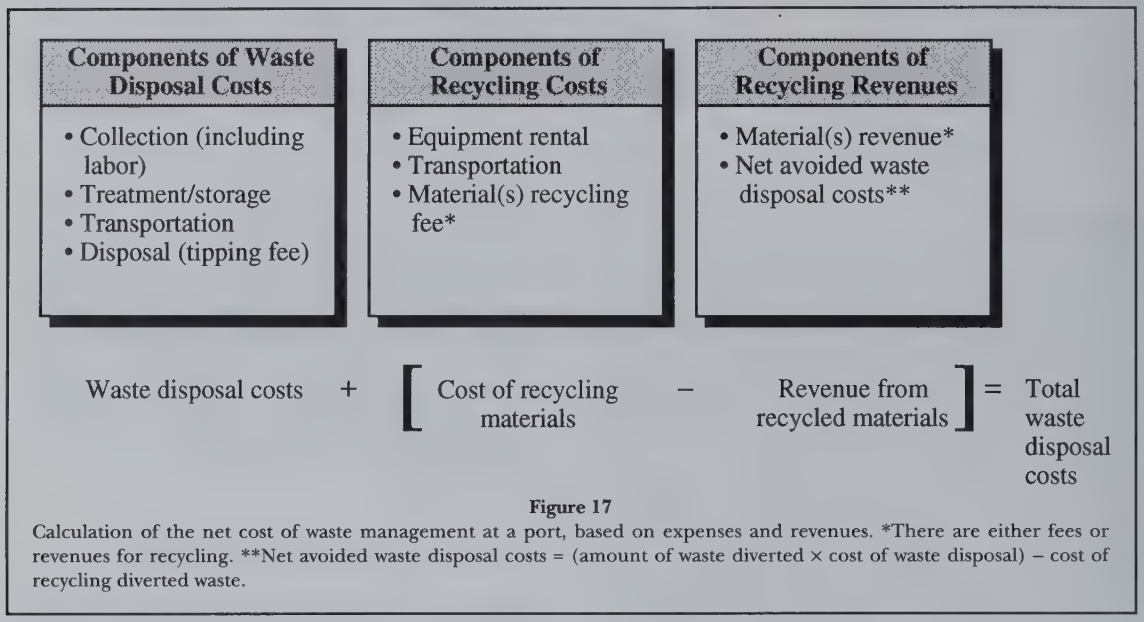

Components of Waste Disposal Costs
• Collection (including labor)
• Treatment/storage
• Transportation
• Disposal (tipping fee)
Components of Recycling Costs
• Equipment rental
• Transportation
• Material(s) recycling fee*
Components of Recycling Revenues
• Material(s) revenue*
• Net avoided waste disposal costs**
Waste disposal costs + [Cost of recycling materials − Revenue from recycled materials] = Total waste disposal costs

Figure 17

Calculation of the net cost of waste management at a port, based on expenses and revenues. *There are either fees or revenues for recycling. **Net avoided waste disposal costs = (amount of waste diverted × cost of waste disposal) – cost of recycling diverted waste.

sea. While a port may prefer to have vessels offload garbage in other ports, it risks loss of business by making the cost of the required service too high. On the other hand, a special use fee for wastes applied to all vessels offers no disincentive for offloading garbage and, if properly set, will just cover the port's waste management costs.

On the whole, ports that provide adequate service at a minimal and uniform cost per unit should retain their competitive position while complying with the law. Again, the absence of stipulations on how to provide and finance adequate reception facilities permits ports to use their ingenuity in solving this problem.

Chapter 5
Encouraging Compliance with Annex V

Compliance with MARPOL Annex V is important for several reasons. Plastic debris is costly to the environment and to coastal communities. Plastic does not disintegrate in the marine environment the way some other materials do. It entangles some animals, is ingested by others, and washes up on beaches as litter. Although compliance is encouraged through surveillance, enforcement, and penalties, competing priorities, limited agency resources, and the vast number of vessels and ports covered by MARPOL Annex V make enforcement difficult. Therefore, compliance depends heavily on voluntary efforts by seafarers. Incentives and education are typically used to encourage voluntary compliance. The role of ports in these activities is discussed briefly below.

Incentives

Well-planned port reception facilities for garbage encourage use if they are viewed by seafarers as convenient and reasonably priced. Conversely, facilities discourage use when they are not convenient or are costly. Convenience includes both facility location in relation to location of vessels in port, and administrative procedures necessary to gain access to port reception facilities. The siting and equipment factors detailed in Chapter 2 (e.g., receptacle capacity, lighting, access, and security), when integrated into a well-planned waste management strategy, promote use of a facility. Ports should be aware that Coast Guard regulations not only encourage citizens to report dumping violations by ships, but also encourage seafarers to report inadequate port reception facilities (see Appendix 2).

Education

Education plays a major role in gaining voluntary compliance. Seafarers must become aware both of the requirements of Annex V, and of how garbage is handled in each port they use. Once seafarers understand the importance of compliance and the reasons for restrictions on at-sea disposal of garbage, it is easier for them to comply. Education is also a tool in promoting the establishment and use of port reception facilities for garbage.

For ports, providing adequate and accessible reception facilities is good business practice, in addition to being required by law. Good garbage facilities promote good user and community relations, ensure retention of the port's certificate of adequacy, and minimize the loss of opportunities from tourism and clean-up costs associated with a filthy port and illegal dumping.

There is an abundance of material available to assist ports with their education efforts. These include posters, brochures, stickers, and placards developed specifically to educate seafarers about Annex V and the consequences of at-sea disposal of plastics and other material. Ports can provide a service to their users by making these materials readily available. There are also case studies of port projects on implementing MARPOL Annex V which detail what was done and what lessons and insights were gained. These materials can be used by themselves or incorporated by solid-waste management planners into unique education and awareness programs.

Many of the education materials have been collected and are distributed through Marine Safety Offices at U.S. Coast Guard district offices around the country.

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Appendix 1
MARPOL Annex V, Regulations for the Prevention of Pollution by Garbage From Ships

Regulation 1: Definitions

For the purpose of this Annex:

(1) "Garbage" means all kinds of victual, domestic and operational waste excluding fresh fish and parts thereof, generated during the normal operation of the ship and liable to be disposed of continuously or periodically except those substances which are defined or listed in other Annexes to the present Convention.

(2) "Nearest land." The term "from the nearest land" means from the baseline from which the territorial sea of the territory in question is established in accordance with international law except that, for the purposes of the present Convention "from the nearest land" off the northeastern coast of Australia shall mean from a line drawn from a point on the coast of Australia in latitude 11°00' South, longitude 142°08' East

to a point in latitude 10°35' South, longitude 141°55' East,
thence to a point latitude 10°00' South, longitude 142°00' East,
thence to a point latitude 9°10' South, longitude 143°52' East,
thence to a point latitude 9°00' South, longitude 144°30' East,
thence to a point latitude 13°00' South, longitude 144°00' East,
thence to a point latitude 15°00' South, longitude 146°00' East,
thence to a point latitude 18°00' South, longitude 147°00' East,
thence to a point latitude 21°00' South, longitude 153°00' East,
thence to a point on the coast of Australia in latitude 24°42' South, longitude 153°15' East.

(3) "Special area" means a sea area where for recognized technical reasons in relation to its oceanographical and ecological condition and to the particular character of its traffic the adoption of special mandatory methods for the prevention of sea pollution by garbage is required. Special areas shall include those listed in Regulation 5 of this Annex.

Regulation 2: Application

The provisions of this Annex shall apply to all ships.

Regulation 3: Disposal of Garbage Outside Special Areas

(1) Subject to the provisions of Regulations 4, 5 and 6 of this Annex:

(a) the disposal into the sea of all plastics, including but not limited to synthetic ropes, synthetic fishing nets and plastic garbage bags is prohibited;

(b) the disposal into the sea of the following garbage shall be made as far as practicable from the nearest land but in any case is prohibited if the distance from the nearest land is less than:

(i) 25 nautical miles for dunnage, lining and packing materials which will float;

(ii) 12 nautical miles for food wastes and all other garbage including paper products, rags, glass, metal, bottles, crockery and similar refuse;

(c) disposal into the sea of garbage specified in subparagraph (b)(ii) of this Regulation may be permitted when it has passed through a comminuter or grinder and made as far as practicable from the nearest land but in any case is prohibited if the distance from the nearest land is less than 3 nautical miles. Such comminuted or ground garbage shall be capable of passing through a screen with openings no greater than 25 millimeters.

(2) When the garbage is mixed with other discharges having different disposal or discharge requirements the more stringent requirements shall apply.

Regulation 4: Special Requirements for Disposal of Garbage

(1) Subject to the provisions of paragraph (2) of this Regulation, the disposal of any materials regulated by this Annex is prohibited from fixed or floating platforms engaged in the exploration, exploitation and associated offshore processing of seabed mineral resources, and from all other ships when alongside or within 500 meters of such platforms.

(2) The disposal into the sea of food wastes may be permitted when they have been passed through a comminuter or grinder from such fixed or floating platforms located more than 12 nautical miles from land and all other ships when alongside or within 500 meters of such platforms. Such comminuted or ground food wastes shall be capable of passing through a screen with openings no greater than 25 millimeters.

Regulation 5: Disposal of Garbage Within Special Areas

(1) For the purposes of this Annex the special areas are the Mediterranean Sea area, the Baltic Sea area, the Black Sea area, the Red Sea area and the "Gulfs area" which are defined as follows:

(a) The Mediterranean Sea area means the Mediterranean Sea proper including the gulfs and seas therein with the boundary between the Mediterranean and the Black Sea constituted by the 41°N parallel and bounded to the west by the Straits of Gibraltar at the meridian of 5°36'W.

(b) The Baltic Sea area means the Baltic Sea proper with the Gulf of Bothnia and the Gulf of Finland and the entrance to the Baltic Sea bounded by the parallel of the Skaw in the Skagerrak at 57°44.8'N.

(c) The Black Sea area means the Black Sea proper with the boundary between the Mediterranean and the Black Sea constituted by the parallel 41°N.

(d) The Red Sea area means the Red Sea proper including the Gulfs of Suez and Aqaba bounded at the south by the rhumb line between Ras si Ane (12°8.5'N, 43°19.6'E) and Husn Murad (12°40.4'N, 43°30.2'E).

(e) The "Gulfs area" means the sea area located north west of the rhumb line between Ras al Hadd (22°30'N, 59°48'E) and Ras al Fasteh (25°04'N, 61°25'E).

(2) Subject to the provisions of Regulation 6 of this Annex:

(a) disposal into the sea of the following is prohibited:

(i) all plastics, including but not limited to synthetic ropes, synthetic fishing nets and plastic garbage bags; and

(ii) all other garbage, including paper products, rags, glass, metal, bottles, crockery, dunnage, lining and packing materials;

(b) disposal into the sea of food wastes shall be made as far as practicable from land, but in any case not less than 12 nautical miles from the nearest land.

(3) When the garbage is mixed with other discharges having different disposal or discharge requirements the more stringent requirements shall apply.

(4) Reception facilities within special areas:

(a) The Government of each Party to the Convention, the coastline of which borders a special area undertakes to ensure that as soon as possible in all ports within a special area, adequate reception facilities are provided in accordance with Regulation 7 of this Annex, taking into account the special needs of ships operating in these areas.

(b) The Government of each Party concerned shall notify the Organization of the measures taken pursuant to subparagraph (a) of this Regulation. Upon receipt of sufficient notifications the Organization shall establish a date from which the requirements of this Regulation in respect of the area in question shall take effect. The Organization shall notify all Parties of the date so established no less than twelve months in advance of that date.

(c) After the date so established, ships calling also at ports in these special areas where such facilities are not yet available, shall fully comply with the requirements of this Regulation.

Regulation 6: Exceptions

Regulations 3, 4 and 5 of this Annex shall not apply to:

(a) the disposal of garbage from a ship necessary for the purpose of securing the safety of a ship and those on board or saving life at sea; or

(b) the escape of garbage resulting from damage to a ship or its equipment provided all reasonable precautions have been taken before and after the occurrence of the damage, for the purpose of preventing or minimizing the escape; or

(c) the accidental loss of synthetic fishing nets or synthetic material incidental to the repair of such nets, provided that all reasonable precautions have been taken to prevent such loss.

Regulation 7: Reception Facilities

(1) The Government of each Party to the Convention undertakes to ensure the provision of facilities at ports and terminals for the reception of garbage, without causing undue delay to ships, and according to the needs of the ships using them.

(2) The Government of each Party shall notify the Organization for transmission to the Parties concerned of all cases where the facilities provided under this Regulation are alleged to be inadequate.

Appendix 2
Form for Reporting Alleged Inadequacy of Port Reception Facilities for Garbage

1. Country: _____

   Name of port or area: _____

   Location in the port (e.g., berth/terminal/jetty): _____

   Date of incident: _____

2. Type and amount of garbage for discharge to facility:

   a. Total amount:
   - food waste ..... m^3
   - cargo associated waste ..... m^3
   - maintenance waste ..... m^3
   - other ..... m^3

   b. Amount not accepted by the facility:
   - food waste ..... m^3
   - cargo associated waste ..... m^3
   - maintenance waste ..... m^3
   - other ..... m^3

3. Special problems encountered:
   - ☐ undue delay
   - ☐ inconvenient locality of facilities
   - ☐ unreasonable charges for use of facilities
   - ☐ use of facility not technically possible
   - ☐ special national regulations
   - ☐ other _____

4. Remarks (e.g., information received from port authorities or operators of reception facilities: reasons given concerning 2, above):

   _____

   _____

   _____

5. Ship's particulars: _____

   Name of ship: _____

   Owner or operator: _____

   Distinctive number of letters: _____

   Port of registry: _____

   Number of persons on board: _____

_____ Date of completion of form

_____ Signature of Master

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